New Scientist

IS MEAT ALWAYS MURDER?
Peter Singer on animal rights in the age of climate change

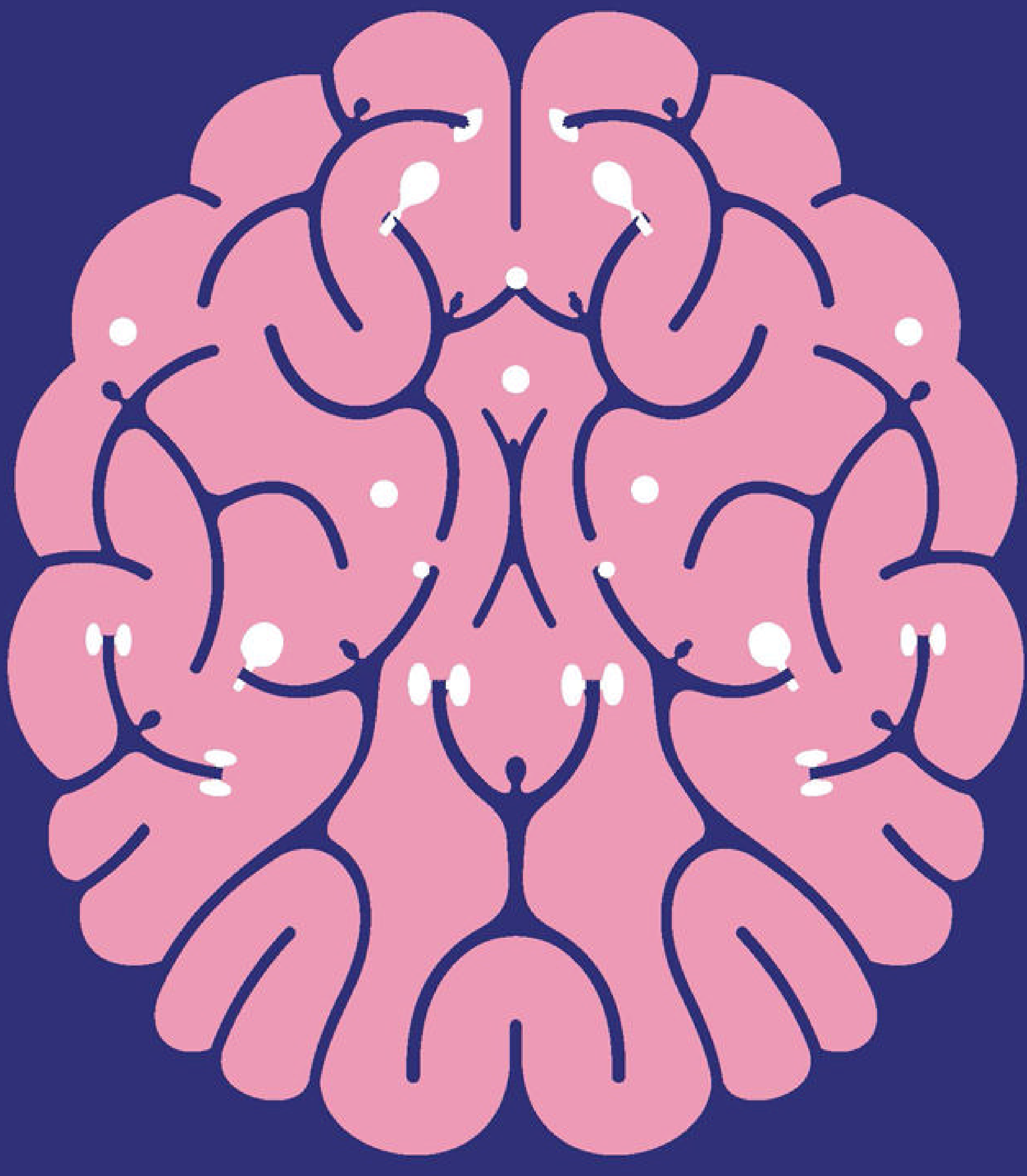
THE OMG PARTICLE
Where are ultra-powerful cosmic rays coming from?

ACTORS TAKE ON AI
Hollywood stars fight to control their digital twins

WEEKLY June 3 - 9 2023

THE ULTIMATE BRAIN WORKOUT

How you can harness the power of exercise to boost your mood and sharpen your thinking



No3441 US$7.99 CAN$9.99

PLUS BACKYARD SUPERNOVA / ETHICAL CHEESE / **THE LIMITS OF GENIUS** / BEST CLOCK IN THE UNIVERSE / **MEDICINAL FROGS**

Science and technology news **www.newscientist.com**

VISIT…

LANZAROTE Caliente.com

ANNOUNCEMENT

AN EVENING WITH DR. ZAHI HAWASS

THE WORLD'S MOST FAMOUS ARCHAEOLOGIST



"THE TIME TO REVEAL THE MOST CLOSELY GUARDED SECRETS OF ANCIENT EGYPT HAS FINALLY COME!

Join me to explore some of the greatest mysteries of the past. I will share the latest research and groundbreaking new discoveries that haven't been announced to the public yet. Don't be surprised when these unexpected revelations make news across the world. This evening will be one to remember!" – **Dr. Zahi Hawass**

GRAND LECTURE TOUR
MAY & JUNE 2023

May 2	Phoenix, AZ
May 4	Los Angeles, CA
May 5	San Diego, CA
May 8	San Francisco, CA
May 11	Seattle, WA
May 13	Portland, OR
May 17	Denver, CO
May 20	Kansas City, MO
May 22	Minneapolis, MN
May 24	Chicago, IL
May 26	Detroit, MI
May 27	Columbus, OH
May 31	St. Louis, MO
June 5	Atlanta, GA
June 7	Philadelphia, PA
June 9	New York, NY
June 13	Washington, DC
June 16	Miami, FL
June 17	Orlando, FL
June 22	Houston, TX
June 24	Dallas, TX
June 27	San Antonio, TX
June 30	Boston, MA

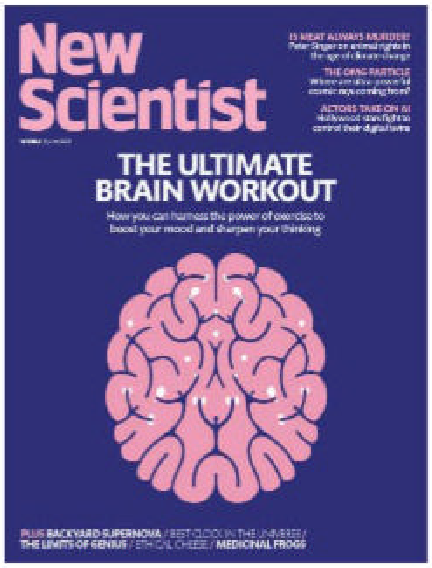
Register now at www.zahilectures.com contact@zahilectures.com +1 646-757-1717

LOST GOLDEN CITY – PYRAMIDS – MUMMIES – KING TUT – CLEOPATRA – & MORE!

This week's issue

On the cover

38 The ultimate brain workout
How you can harness the power of exercise to boost your mood and sharpen your thinking



Vol 258 No 3441
Cover image: Noma Bar

43 Is meat always murder?
Peter Singer on animal rights in the age of climate change

46 The OMG particle
Where are ultra-powerful cosmic rays coming from?

16 Actors take on AI
Hollywood stars fight to control their digital twins

20 Backyard supernova
19 Best clock in the universe
35 The limits of genius
28 Ethical cheese
27 Medicinal frogs

38 Feature

"The best exercise is one that makes you move and think at the same time"

News

8 mRNA therapies
Trial results show potential to revolutionise medicine

12 Flood defence lab
How a UK river serves as a test bed for nature-based solutions

14 Covid-19 in pregnancy
A clearer picture is emerging of the risks posed by infection

Views

27 Comment
Amphibians could help cure our ills, says Matthew Gould

28 The columnist
Graham Lawton digs into the concept of ethical cheese

30 Aperture
Poignant shots of a melting glacier in Uganda

32 Letters
Is it time we looked further for a solution to the diet crisis?

34 Culture
Earth's oceans take centre stage in a new book



TRUSTEES OF THE NATURAL HISTORY MUSEUM LONDON

10 Creatures of the deep Ocean mining zone is home to 5000 species

Features

38 Mental muscle
We are getting to grips with how exercise boosts the brain and how to reap the benefits

43 Ethical diets
How do we balance animal welfare against the need to fight climate change?

46 Small but powerful
Understanding the universe's most energetic particles

The back pages

51 Stargazing at home
Spot the 13th sign of the zodiac

53 Puzzles
Try our crossword, quick quiz and logic puzzle

54 *Almost* the last word
Can drinking tea counteract eating a hot dog?

55 Tom Gauld for *New Scientist*
A cartoonist's take on the world

56 Feedback
Jerky jargon and a ratty theory of everything

Elsewhere on New Scientist

Event

The Search for Dark Matter

Why do researchers believe in the existence of a substance we can't see and that no one has directly detected? Particle physicist Jocelyn Monroe and a panel of *New Scientist* journalists offer a deep dive into the science of dark matter. Join us at Conway Hall in London, or online, on 7 June at 7pm BST/2pm EDT. Tickets are free to this subscriber-only event.

newscientist.com/events



NASA, ESA, V. KSOLL AND D. GOULIERMIS (UNIVERSITÄT HEIDELBERG), ET AL.

Big puzzle Galaxies would behave differently without dark matter

Tour

The science of rewilding: Coombeshead, UK

Explore rewilding in the heart of the English countryside. At the Rewilding Coombeshead project, you will see how water buffalo, wild boar and beavers can help restore wetlands and other ecosystems. Hosted by *New Scientist*'s staff writer Graham Lawton, along with leading ecology experts, the weekend tour begins on 1 September. Tickets from £649.

newscientist.com/tours



NICK UPTON/NATUREPL

Natural engineer Beavers can help restore ecosystems

Podcast

Weekly

The world's largest organism by mass is an aspen grove in Utah – and it may be at risk. The team finds out why. There is also news of new drugs that reliably help people to lose weight. Plus, in a bonus episode, Rowan Hooper visits the Knepp Estate in southern England to talk to rewilding pioneers Isabella Tree and Charlie Burrell.

newscientist.com/nspod

Video

Aquatic nightmares?

On our YouTube channel this week, there is footage of an octopus apparently having a nightmare in its aquarium. While asleep, the animal suddenly begins thrashing around and releases ink as if being attacked by a predator. It is still unclear whether octopuses dream like we do, but the footage may encourage further research.

youtube.com/newscientist

Newsletter

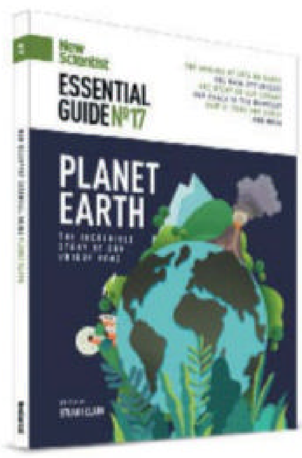
Fix the Planet

European summers are no longer mild, and cities must adapt, writes environment reporter Madeleine Cuff. Plants will be key: Barcelona will soon complete a project to turn five streets into pedestrian-friendly, tree-lined thoroughfares – and there are plans to grow plants on the rooftops of Paris.

newscientist.com/fix-the-planet

Podcast

"The world's largest organism is heavier than 35 blue whales"



Essential guide

Our planet still holds many secrets. How did Earth form? How is it changing with global warming? And are there other Earth-like worlds out there? This *New Scientist Essential Guide* offers answers. Available to download in the *New Scientist* app or to purchase in print from our shop.

shop.newscientist.com

OWN YOUR MIND BUSINESS

Discover what makes you tick with How We're Wired, a brand new podcast that looks at what happens inside your brain – from before you were born through to death.

Presented by anthropologist Dr Anna Machin, this series features real life stories, expert analysis, the latest research and at-home experiments that will open your eyes to the most fascinating organ in the human body.



HOW WE'RE WIRED

fondation bertarelli
fondation-bertarelli.org

Search for **'How We're Wired'** and subscribe wherever you get your podcasts.

Apple Podcasts · Google Podcasts · Spotify

New Scientist Subscriptions

PAY JUST ~~$7.99~~ $3 AN ISSUE



INTRODUCTORY OFFER

SAVE 62%*

Spring in to action. Grab yourself a *New Scientist* subscription today and save 62% on the newsstand price. Plus, you'll get instant access to newscientist.com and the *New Scientist* app.

Visit newscientist.com/19448

or call: +1 888 822 3242, quoting 19448

Scan me for instant sign up on your phone

*Saving shown is calculated as percentage off the newsstand price as compared to 'print and digital' package. 'Digital' package also available. Offer ends 28 June. This is an auto-renewing subscription and at the end of your trial period, your subscription will continue at the full rate. In the unlikely event that you wish to cancel your subscription, we offer a 14-day cooling-off period after initial payment is made.

Food for thought

We have ethical options to replace industrial farming, but it won't be easy

THE industrialised food system is approaching a crossroads. Though it undoubtedly produces more than enough food, it is butting up against ethical and environmental limits. The system, especially factory farming, is doing great damage to the environment, biodiversity, water resources and animal welfare. It is also ultimately self-defeating as soils can't sustain it for much longer – by some estimates we have just 60 harvests left.

But environmental and ethical concerns sometimes come into conflict. As the influential philosopher Peter Singer points out on page 43, it is arguably ethical – from an animal welfare point of view – to eat pasture-raised beef, but the greenhouse gas emissions are still huge.

There are two basic options to change this. One is futuristic: increased intensification of arable farming on smaller areas of land, and technological advances such as precision fermentation to provide animal protein. The other is to revert to ways of the past and rebuild systems known as regenerative farming.

"Regenerative farming can be as productive as industrial – without its environmental toll"

Opponents of the latter claim that this would lead to food shortages. But there is evidence that regenerative agriculture can be as productive as industrial farming – without its environmental toll or harm to animals. And while the industrial system produces enough food to feed 10 billion people, we waste about a third of it.

There are already farming systems that address all of these issues. It is now possible to buy cheese from a carbon-negative farm where the cows live long, contented lives (see page 28). A type of chicken farming, where the birds run free among trees, has been shown to work in Latin America and Canada and is being trialled in the US. The resulting products are pricier than factory-farmed versions, but reflect the true cost of production. We may have to swallow it.

These are baby steps towards the systemic change required. But change is coming. Regenerative farming deserves a fair hearing. Until then, food writer Michael Pollan's advice is best: "Eat food. Not too much. Mostly plants." ■

PUBLISHING & COMMERCIAL

Commercial and events director Adrian Newton

Display advertising
Tel +44 (0)203 615 6456 **Email** displayads@newscientist.com
Sales director Justin Viljoen
Account manager Matthew Belmoh, Mila Gantcheva
Partnerships account manager David Allard

Recruitment advertising
Tel +44 (0)203 615 6458 **Email** nssales@newscientist.com
Recruitment sales manager Viren Vadgama
Key account manager Deepak Wagjiani

New Scientist Events
Tel +44 (0)203 615 6554 **Email** live@newscientist.com
Sales director Jacqui McCarron
Head of event production Martin Davies
Head of product management (Events, Courses & Commercial Projects) Henry Gomm
Marketing manager Emiley Partington
Events and projects executive Georgia Peart
Events and projects coordinator Gemma Dowie
Events team assistant Olivia Abbott

New Scientist Discovery Tours
Director Kevin Currie
Senior product manager Lara Paxton

Marketing & Data
Marketing director Jo Adams
Head of campaign marketing James Nicholson
Digital marketing manager Jonathan Schnaider
Campaign marketing coordinator Charlotte Weeks
Head of customer experience Emma Robinson
Senior customer experience marketing manager Esha Bhabuta
Marketing executive Bethan Smith
Head of CRM & audience data Rachael Dunderdale
Senior email marketing executive Natalie Valls
Email marketing executive Ffion Evans
Junior analyst Hamied Fahim

Technology
Technology director Tom McQuillan
Senior developer and UX designer Amardeep Sian
Senior developers Maria Moreno Garrido, Piotr Walków
Lead digital designer and developer Dan Pudsey
Front end developer Damilola Aigoro
Junior front end developer Matthew Staines
Program manager Jennifer Chilton

NewScientist

Chief executive Nina Wright
Managing director Laurence Taylor
Executive assistant Lorraine Lodge

Finance & operations
Chief financial officer Amee Dixon
Commercial finance manager Charlotte Thabit
Commercial finance manager Anna Labuz
Management accountant Charlie Robinson
Commercial management accountant Alexandra Lewis

Human resources
HR business partner Purnima Subramaniam

CONTACT US
newscientist.com/contact

General & media enquiries
US PO Box 80247, Portland, OR 97280
UK **Tel** +44 (0)203 615 6500
9 Derry Street, London, W8 5HY
Australia 58 Gipps Street, Collingwood, Victoria 3066
US Newsstand **Tel** +1 973 909 5819
Distributed by Time Inc. Retail, a division of Meredith Corporation, 6 Upper Pond Road, Parsippany, NJ 07054
Syndication Tribune Content Agency
Tel 1-800-346-8798 **Email** tca-articlesales@tribpub.com
Subscriptions **newscientist.com/subscribe**
Tel 1 888 822 3242
Email subscriptions.us@newscientist.com
Post New Scientist, PO Box 3806, Chesterfield MO 63006-9953

© 2023 New Scientist Ltd, England.
New Scientist ISSN 0262 4079 is published weekly except for the last week in December by New Scientist Ltd, England. New Scientist (Online) ISSN 2059 5387. New Scientist Limited, 387 Park Avenue South, New York, NY 10016

Periodicals postage paid at New York, NY and other mailing offices. Postmaster: Send address changes to New Scientist, PO Box 3806, Chesterfield, MO 63006-9953, USA. Registered at the Post Office as a newspaper and printed in USA by Quad, 555 South 108th Street, West Allis, WI 53214-1145

EDITORIAL

Editor-in-chief Emily Wilson
Magazine editor Catherine de Lange
News and digital director Penny Sarchet
Creative director Craig Mackie

News
News editor Jacob Aron
Assistant news editors Chris Simms, Alexandra Thompson, Sam Wong
Reporters (UK) Madeleine Cuff, Michael Le Page, Jason Arunn Murugesu, Matthew Sparkes, Alex Wilkins, Clare Wilson, (Aus) Alice Klein

Digital
Acting head of digital Matt Hambly
Podcast editor Rowan Hooper
Head of editorial video David Stock
SEO and analytics manager Finn Grant
Social media manager Chen Ly
Intern Obomate Briggs

Features
Head of features Daniel Cossins and Helen Thomson
Editors Colin Barras, Abigail Beall, Kate Douglas, Alison George, Joshua Howgego, Thomas Lewton
Feature writer Graham Lawton

Culture and Community
Comment and culture editor Alison Flood
Senior culture editor Liz Else

Subeditors
Chief subeditor Eleanor Parsons
Bethan Ackerley, Tom Campbell, Tom Leslie, Jon White

Design
Art editor Ryan Wills
Joe Hetzel

Picture desk
Picture editor Tim Boddy
Assistant picture editor Jenny Quiggin

Production
Production manager Joanne Keogh
Production coordinator Carl Latter

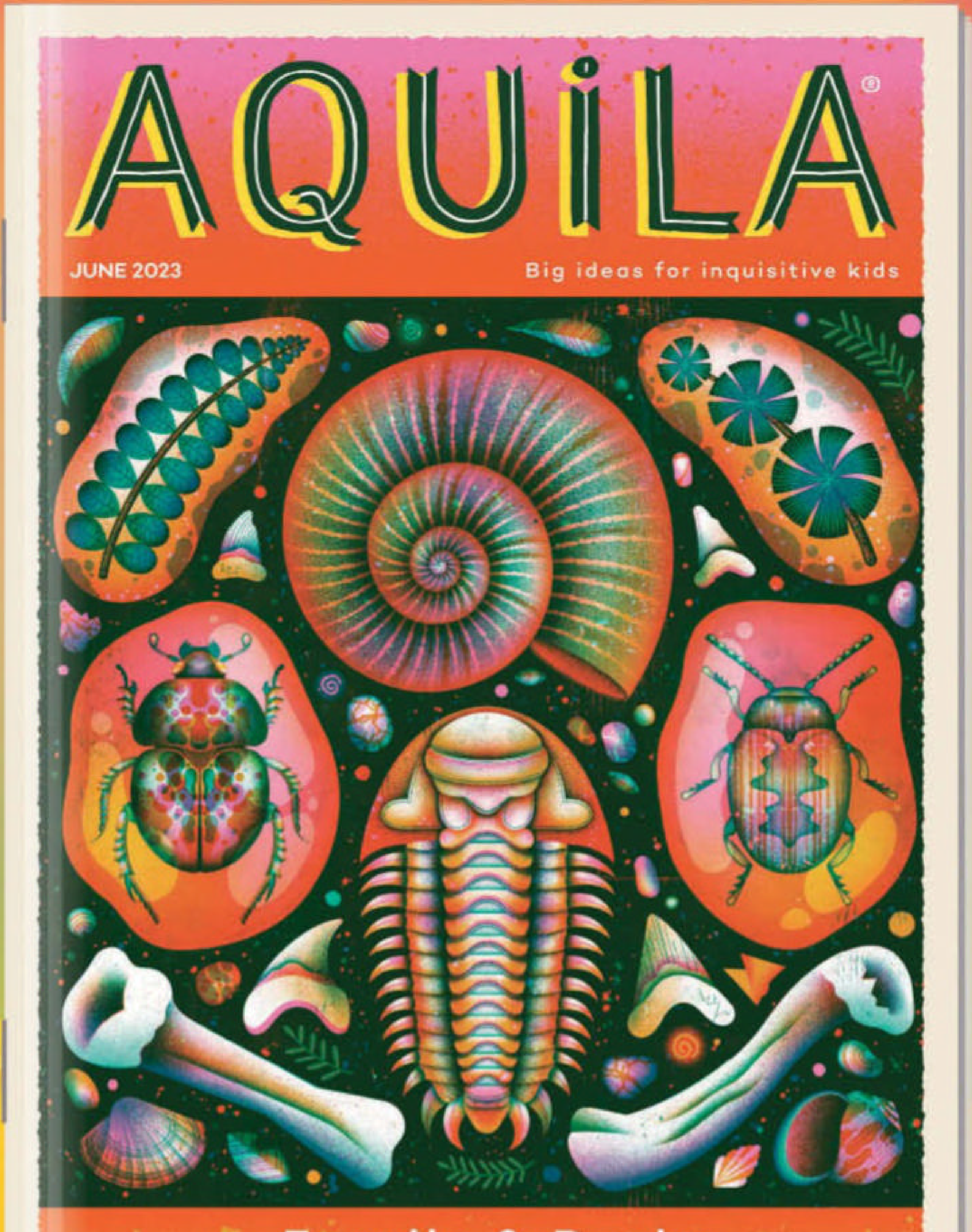
New Scientist US
US Editor Tiffany O'Callaghan
Editors Timothy Revell, Chelsea Whyte
Reporters Leah Crane, James Dinneen, Jeremy Hsu, Karmela Padavic-Callaghan, Grace Wade, Corryn Wetzel
Subeditor Alexis Wnuk

Philosophical, curious & puzzling...

Imagine a monthly children's publication where ingenious puzzles and serious science are brought to life with cheeky humour and colourful contemporary illustrations. In award-winning **AQUILA Children's Magazine** every topic is designed to bring real depth and colour to children's understanding of our complex world.

Brilliant reading for kids of 8 –14

Save 42%
With Code: NS6423
Expires 15/07/23. UK only. 4 month subscription for £20. Summer Double issue counts as 2 magazines. No auto-renewal



This month's topic: FOSSILS
Kids adore hunting for fossils! AQUILA brings this fascinating subject right up to date, with lots of science and history, and some glorious art and craft projects. PLUS: fun challenges from our regular guests, TASKMASTER® Education!

"Gets grown-ups as excited as children..."
Winner Youth Category 2021 & 2022 - British Society of Magazine Editors

- **Stimulating Articles**
- **Puzzles & Creativity**
- **Experiments & Crafts**
- **Serious Fun!**

Scan code to find out more:

AQUILA.CO.UK

News

First contact
Fake alien message transmitted to Earth from Mars p9

Privacy leaks
US police sell seized mobile phones with personal data p10

How to defeat AI
Chatbots flummoxed by extraneous capital letters p11

Sound asleep
Ultrasound triggers hibernation-like state in mice p13

Treating paralysis
Implants help man walk again after spine injury p20

Environment

Floods follow drought in Italy

Intense rainstorms have caused devastating floods in the Italian region of Emilia–Romagna, killing at least 15 people and displacing some 36,000. The downpours were preceded by a long drought that parched the soil, hindering its ability to absorb water. The Italian government has promised to accelerate work on a climate adaptation plan.



ANTONIO MASIELLO/GETTY IMAGES

Analysis Medicine

Trial shows how mRNA therapies could revolutionise medicine

People with a rare genetic condition had fewer symptoms after getting an experimental mRNA drug, and the technology could treat many disorders, says **Michael Le Page**

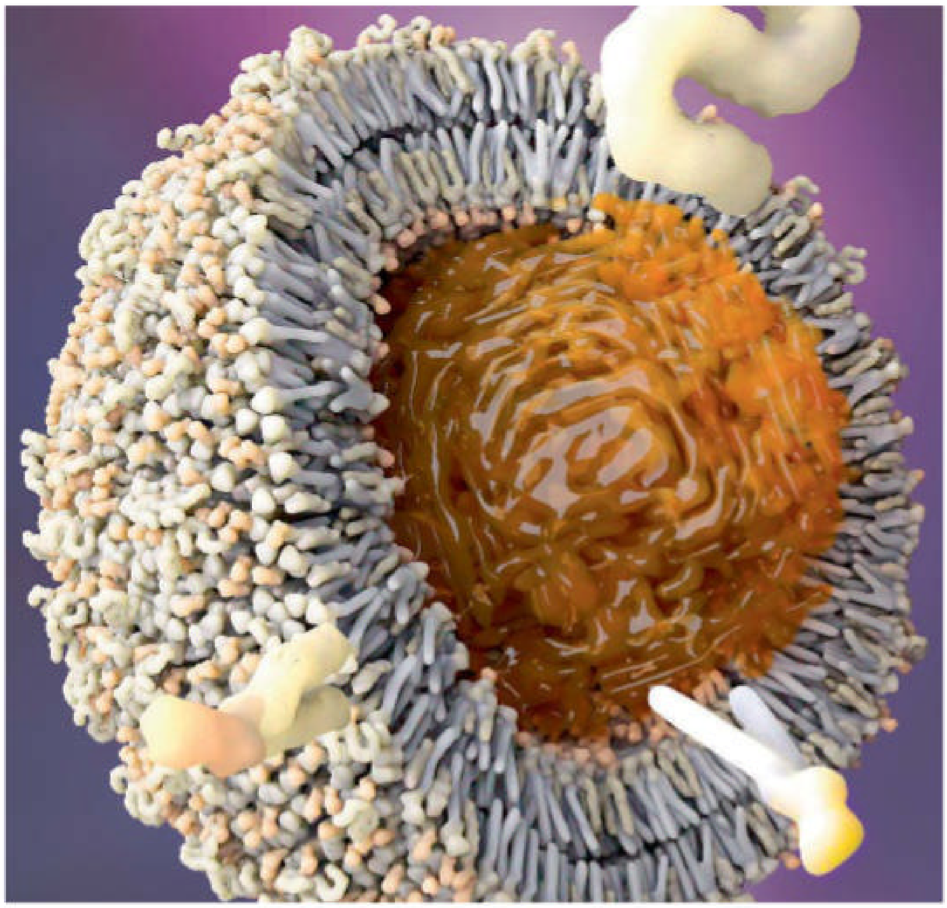
SIXTEEN people have benefited from an experimental mRNA therapy that replaces a faulty enzyme behind a rare inherited condition, the biotech company Moderna announced on 19 May. This is great news for those with this condition, but its significance extends further: if this kind of mRNA therapy proves to be safe and effective, it could help treat a huge range of conditions and might even revolutionise medicine.

The people in the trial, aged 1 year and up, have a condition called propionic acidemia. This is caused by mutations in the gene for an enzyme that helps break down some components of proteins. When the enzyme is faulty, cells in the liver can't do their job and toxic chemicals build up in the blood, damaging many organs, from the heart to the brain.

If untreated, the condition is usually fatal. But with treatment, including a tightly controlled diet, the prospects are much better. Even so, many people still have episodes where toxins build up to dangerous levels, such as during infections. This causes vomiting and lethargy, and can lead to comas.

Moderna's treatment consists of mRNAs, the templates that cells use to make proteins, such as enzymes. The mRNAs are encased in fatty droplets to protect them while they are in the bloodstream. The droplets fuse with liver cells and release the mRNAs inside them. The cells then use the mRNAs to make working versions of the enzyme.

The principle is exactly the same as that of the mRNA covid-19 vaccines that millions of people have now received. However, in the case of the Moderna trial, the mRNAs are injected directly into the bloodstream so they can reach the liver, and bigger doses are required. Because mRNAs don't persist in cells, the trial participants were given injections every two weeks.



RAMON ANDRADE 3DCIENCIA/SCIENCE PHOTO LIBRARY

Molecules of mRNA (brown) are packed inside a layer of fat-like lipids so they can be injected into people in treatments and vaccines

Five of the 16 people have been receiving the treatment for more than a year and the therapy is "well-tolerated", according to Moderna. Those receiving it have had fewer or no episodes caused by a toxin build-up, it says.

"This is the first clinical trial reporting results of an mRNA therapeutic for intracellular protein replacement," Kyle Holen at Moderna said in a statement.

Why is this news exciting for the entire field of medicine, not just for those people with this condition? At the moment, most drugs are small molecules. They have the advantages of being cheap to make – if not necessarily to buy – and being able to diffuse through the gut into the bloodstream and then through the cell membrane into cells.

The disadvantage of their small size is that they don't bind precisely to their targets, often attaching to non-target sites as well – like a tiny jigsaw puzzle piece that can fit in lots of places it doesn't belong. This is why they often have lots of side effects.

Large molecules such as proteins are more precise and powerful than small molecules, but proteins are difficult to manufacture. They also can't get through the gut wall and can't get from the blood into cells. Injecting proteins gets around the issue of passing through the gut wall, but doesn't solve the other two issues.

There are a growing number of protein-based drugs, mostly artificial antibodies designed to treat infections or cancers. Many are extremely effective – but they are also extremely expensive and their uses are limited, as none gets inside cells. mRNAs could solve these issues too, as they are cheap to make compared with proteins and this Moderna trial shows you can use them to effectively get proteins inside cells.

> "It is relatively easy to deliver mRNAs to liver cells because the liver mops up anything in the blood"

That said, there were a lot of adverse events in the trial, says Anna Blakney at the University of British Columbia, Canada, suggesting the dosage was at the limits of what is safe.

It is also relatively easy to deliver mRNAs to liver cells because the liver mops up anything added to the blood. To treat many conditions, mRNAs will need to be delivered to other cell types, which remains a challenge.

So, there is still a long way to go before mRNA shots are used to treat a range of conditions, but given that many pioneering treatments fail altogether, this is an excellent start. "It's definitely promising and a step forward for the field," says Blakney. ■

Physics

Sunlight could cool a charged atom to its coldest possible limit

Karmela Padavic-Callaghan

CHARGED atoms could be taken to their lowest temperature allowed by the laws of physics with the help of sunlight.

In the 1990s, several people won Nobel prizes for working out how to make atoms extremely cold with precisely controlled laser light. Now, Amanda Younes and Wesley Campbell at the University of California, Los Angeles, have found that some parts of the cooling process could be done with light straight from the sun.

The researchers calculated how a positively charged barium atom, or ion, kept in a device called an ion trap could be cooled in two steps.

First, it would be hit with a laser to slow it down, reducing its energy and therefore its temperature.

Then, the temperature could be lowered further by decreasing the atom's entropy – a measure of the disorder of the system. Younes and Campbell found that just getting some sunlight onto the ion would accomplish this. Normally, researchers would use a different-coloured laser.

"You could probably just do this outdoors, but it would be tricky to set up an ion trap outside," says Younes.

In the pair's scheme, sunlight would be transmitted onto the ion through one end of an optical fibre, with the other end on the roof focusing sunlight through a glass lens (arXiv, doi.org/kb9t).

The researchers calculate that electrons in the ion would absorb so much energy that they would become unstable. At this point, they would have to release some energy as light. This would decrease their entropy and they would end up stuck in their lowest possible energy state, only about a millionth of a degree above absolute zero.

Younes says she has already built the fibre to test the process and is expecting to shine it onto an actual barium ion soon. ▮

Space

Fake alien message sent to Earth to mimic first contact

Jonathan O'Callaghan

A MESSAGE has been sent to Earth from a spacecraft orbiting Mars, to simulate potential communication from an advanced alien civilisation.

On 24 May, a spacecraft at Mars, the Trace Gas Orbiter (TGO), was used to send a coded message – just a few kilobytes in size – to our planet. Picked up by radio receivers on Earth, groups of astronomers and enthusiasts then set to work decoding it, a potential dry run for first contact.

"This kind of experiment is long overdue," says Franck Marchis at the SETI Institute in California, who helped to coordinate the event. "We have been searching for extraterrestrial signals for more than 60 years, but we never really thought about what receiving and decoding such a signal would be like."

300m

Number of kilometres between the Martian orbiter that sent the signal and Earth

16

Number of minutes it took the transmission to reach Earth

The project, called A Sign in Space, was led by artist Daniela de Paulis in Rome, who was put in touch with the European Space Agency (ESA) to use the TGO spacecraft. The goal was to assess how, if we ever picked up a radio signal from an alien civilisation, humans might respond. "Having a Martian source makes the project immediately more relatable," she says. "The source of the signal is truly in outer space."

It took 16 minutes for the transmission to get from Mars to Earth owing to the current distance of nearly 300 million kilometres between the two planets. The data was picked up by several radio telescopes on Earth, including the SETI Institute's Allen Telescope Array in California and the Green Bank Observatory in West Virginia.

Groups on Earth then began trying to decode the message, the contents of which were kept closely under wraps. Neill Sanders at UK astronomy group Go Stargazing was one of those involved in attempting to decipher the message. "It's fascinating," he says. "It gives us a little sense of what would happen if we really did get a signal, everything from capturing the signal to processing the data."

Golden record

The science mission of TGO, which studies the atmosphere of Mars from 400 kilometres above its surface, wasn't affected by the project, says Tiago Loureiro at ESA's European Space Operations Centre in Germany. "We explored options on how this could be done without disturbing the spacecraft's operations," he says.

Messages have been sent by humans into space before in attempts to make first contact, such as the Arecibo message in 1974 that was beamed to a nearby galaxy cluster. NASA's twin Voyager spacecraft – both now beyond the solar system – also contain a "golden record" with information about planet Earth. Despite the suspected billions of planets in our galaxy, however, we have never encountered a message coming the other way – until now.

The message had yet to be decoded as *New Scientist* went to press, but de Paulis hopes that its eventual decipherment will encourage discussion of what it might mean to make first contact. "How would we make sense of such a thing?" she says. "The project is really a way to highlight this very human philosophical process of making meaning around something." ▮



SETH SHOSTAK/SETI INSTITUTE

The Allen Telescope Array in California detected the message

Technology

Privacy leaks from seized US phones

Nude photos and bank details were found on devices sold by US police forces via auction site

Matthew Sparkes

MOBILE phones seized in US criminal investigations are being sold online with personal data like emails, bank details and nude photos intact. Security experts warn that the practice enables hackers to buy phones and commit the same crimes with the same data and victims.

Various US states have laws letting police forces dispose of lost-and-found items if they aren't collected within a certain time, as well as devices that were used or seized in criminal investigations.

Richard Roberts at the University of Maryland and his colleagues bought 228 mobile phones that were being disposed of by police departments on the auction site PropertyRoom, paying an average of just $18.

Although many of the phones were protected by a PIN, the researchers were able to access 61 of them: 49 weren't locked at all and another 11 used common, easily guessed passcodes. One even arrived with a police note listing the PIN, apparently having been broken into to extract data.

One phone, which the team believes was used by an identity fraudster, had 24 credit reports stored on it, with the identity, bank account details, employment record and social security numbers linked. Other phones had stored credit card details, some stolen. Images of government-issued IDs and scans of five passports and 14 driver's licences were also found.

As well as the financial and identity information, the team found personal data including nude photographs, messages to friends and family and web browsing histories. Some phones included communication between sex workers and clients (go.umd.edu/3MuoKxu).

"If these phones aren't being handled properly, you risk creating this cycle of people who are already victims of identity theft or some other crime having their data recirculating," says Roberts. "I think there's a clear problem at the police department level, because PropertyRoom runs the largest online police auction house in the US, but it's not the only place. So if this problem was trickling down to them, it's likely trickling down through to other places too."

> "If these phones aren't being handled properly, you risk creating this cycle of repeated identity theft"

Roberts says such phones should be destroyed or wiped. "No one should have their information be sold in this manner, including people who did commit criminal acts," he says. "We have every text message they send to every person they know; we have every email they send to every person; we have their phone call history."

A PropertyRoom spokesperson said: "PropertyRoom.com has always had policies and processes in place to wipe working smartphones before going to auction and auction other non-working phones sold for parts only. We do our best to continuously review our processes to ensure they are keeping up with the fast-changing digital landscape. We have updated our processes to ensure that no smartphones or electronics will be auctioned on PropertyRoom.com that aren't wiped, locked, reset to factory settings, or hard drives/storage drives removed and destroyed." ■

Marine biology

5000 novel species live in deep-sea mining area



TRUSTEES OF THE NATURAL HISTORY MUSEUM LONDON

A sea cucumber from the Clarion-Clipperton Zone in the Pacific Ocean

AN AREA of the Pacific Ocean that is due to be carved up and mined for valuable minerals is home to more than 5000 species that have never been found anywhere else on Earth.

Mining companies are eager to harvest nodules of manganese, nickel and copper found at depths of over 4000 metres in the Clarion-Clipperton Zone (CCZ), an area around twice as large as India.

To get a better picture of the biodiversity that is under threat from proposed mining, Muriel Rabone at the Natural History Museum in London and her colleagues reviewed all available data from scientific expeditions on what species live there.

They have found evidence for 5578 different species in the CCZ, with as many as 92 per cent being entirely new to science. Only six of the new species found in the CCZ, which include a sea cucumber, a nematode and a carnivorous sponge, have been seen in other regions (*Current Biology*, doi.org/gr9d3f).

Rabone, who has been on surveys in the region, says she saw new species every time a sample was lifted to the surface. She believes that current data is the "tip of the iceberg" in terms of understanding the biodiversity of the CCZ and predicts that there are 6000 to 8000 more unknown species.

"I think it would be ill-advised to be pushing ahead with mining without adequate knowledge," she says. "Most of the species appear to be very rare."

Pradeep Singh at the Research Institute for Sustainability in Potsdam, Germany, says that, while no commercial mining has taken place yet in the CCZ, there have been small-scale mining tests. The region has been divided up and assigned to various companies, but delays in developing regulations for deep-sea mining are holding up the start of operations. ■

MS

Artificial intelligence

Test using capital letters easily sorts AIs from humans

Chris Stokel-Walker

A CLEVER use of capital letters could be an easy way to flummox artificial intelligences like ChatGPT, letting people distinguish them from humans in conversation.

The idea is reminiscent of the Turing test, proposed by computer scientist Alan Turing in 1950. He said that an AI would be considered truly intelligent once we couldn't distinguish its answers from a human's. Now that large language models (LLMs) like ChatGPT can sound convincingly human, Hong Wang at the University of California, Santa Barbara (UCSB), and his colleagues wanted to find other ways to weed out the machines.

The team tried several tests. One asks the LLM to identify what is depicted in images created using text characters, known as ASCII art. Another asks questions obscured by capital letters that change the meaning of the words or produce nonsense: for instance, "isCURIOSITY waterARCANE wetTURBULENT orILLUSION drySAUNA?", for which the expected answer is "wet".

The team tested five LLMs, including Meta's LLaMA and OpenAI's GPT-3 and ChatGPT. All of them failed the capital letters test and only ChatGPT managed to score on the ASCII test, with a paltry 8 per cent accuracy. By comparison, when the team asked 10 people to take the same tests, they achieved 100 per cent accuracy on the capital letters test and 94 per cent on the ASCII test (arXiv, doi.org/kb8t). "Humans like to find and recognise patterns," says Wang.

Although LLMs fail the tests now, they might learn to pass them with further training. However, team member Weizhi Wang, also at UCSB, believes that won't happen because of the way LLMs break text up into chunks to process the data. "Humans understand the test at a word level," he says, but AIs don't. ▮

Human development

Babies can identify people's faces from just 4 months old

Jason Arunn Murugesu



MIODRAG IGNJATOVIC/GETTY IMAGES

Babies like their parents' faces, but a stranger's can upset them

INFANTS may be able to identify people's faces before anything else, such as cars or letters of the alphabet. It now seems that babies as young as 4 months old produce a distinct brain signal when they see an image of someone's face, which could explain why some children become scared of strangers at around this age.

Kalanit Grill-Spector at Stanford University in California and her colleagues wanted to better understand how infants interpret the world around them.

To do so, they studied the brain activity of 45 children, who were between 3 and 15 months old, while they looked at a series of rapidly appearing images: strangers' faces, corridors, cars, letters and human limbs. The team chose these images, which were all grey, as they are regularly present in most children's lives, says Grill-Spector.

The children were shown the images on a screen for 1 minute at a time. The researchers repeated the 1-minute experiment six to 12 times per child while they wore an electroencephalogram headset to measure their brain activity.

The team found that the images of faces elicited a distinguishable brain signal in the participants from just 4 months old. This became more robust in the children who were between 6 and 8 months old, the same age that corridors and limbs started to elicit a similar signal. Letters generated such a signal at 12 to 15 months old, but none of the children produced a distinct brain signal when looking at cars (bioRxiv, doi.org/kb9p).

> "Infants can tell faces apart from other objects like limbs and cars"

Producing these brain signals suggests that each child is identifying the category of object that the image belongs to, says Grill-Spector. "So, for faces, we're saying the infants can appreciate that they're all similar in some ways and belong to the same category of objects," she says. "They can tell these apart from other objects like limbs and cars."

The results are in line with previous research suggesting that babies become afraid of strangers at around 8 months old, says Grill-Spector. "It might take time for babies' retinas to mature to a level where you can really tell people apart from their faces."

Babies may also recognise faces relatively early on in their lives because these are what they spend most of their time looking at, says Grill-Spector. "It's only when a child is around 1 year old that they're mobile and dexterous and they're interacting with a lot of objects," she says.

Measuring how seeing different objects relates to brain activity could one day help diagnose children with autism, says Grill-Spector. People with autism can have some differences in their facial perception, she says. "Analysing this brain signal could be a way to detect autism in a pre-verbal infant." Further research into this is required, she says.

"This study addresses the fundamental question of how infants structure and make sense of the barrage of information from their novel and complex visual world," says Anna Franklin at the University of Sussex, UK. "The methodological innovations of the study pave the way for identifying when the infant brain selectively represents many other types of visual categories, such as food." ▮

Field notes Eddleston Water, UK



How a UK river serves as a natural lab for flood research

Work at Eddleston Water has provided ecological benefits worth millions of pounds, finds **Jason Arunn Murugesu**

WHEN I visit a research lab, I don't normally expect to have to dodge sheep or get my shoes muddy, but this lab is far from normal. I am walking on farmland, about 30 kilometres outside Edinburgh, UK. The air is crisp and I can hear a river babbling as I approach.

It is this stretch of river, Eddleston Water, that I have come to see, guided by Chris Spray at the University of Dundee, UK. Spray and his team started studying the river in 2009 and it has been home to a series of real-world experiments ever since. They call it a "natural lab" for river science.

As we watch a dipper popping in and out of the river in search of prey, Spray tells me the lab was originally set up to cut the flood risk facing Peebles, a town of 9000 people on Eddleston Water.

Spray and his colleagues wanted to find out how they could reduce risk using nature-based solutions, such as tree planting, rather than building dams. They also wanted to find out how effective these methods really are. "Models are great and all, but it's only with real-world data that you get a full understanding of all the various factors that can affect these results," says Spray.

Such methods, also known as natural flood management (NFM), are gaining traction: the UK government plans to double the number of flood reduction and coastal erosion projects in England using NFM from 60 to 120. But, despite this, the evidence for NFM is relatively sparse, says Spray.

One big question in hydrology is what happens when you make a river bend more, also known as re-meandering. Many of the UK's rivers were straightened to free up room for roads and railways, but we now know this also increases the risk of floods. The idea goes that re-meandering rivers allows them to hold a greater volume of water and so avoid flooding.

Yet Spray's team has found that, at least in Eddleston Water, re-meandering alone doesn't seem to have a major effect on flood risk. This is because the floodplain surrounding the newly bendy river isn't particularly large, so can't effectively store the water that overflows due to excess rain. But that doesn't mean there aren't benefits: a bendier river boosts ecological diversity, says Spray.

For example, the team found an increase in the number of spawning habitats for salmon in re-meandered sections of the river. This is one of the reasons why the dipper is trying its luck in the river today, says Spray.

The water also flows faster in the bendier bits, which contain more oxygen and can give rise to a greater variety of insect life. These parts of the river seem more alive than unrestored sections.

The researchers have studied leaky dams, too, which are simply tree logs placed across a stream. During normal river flow, the water passes under the logs, but when river levels rise, the dams slow the flow of water.

Spray shows me one of these dams, comprised of a dozen logs lying across a stretch of the river. It looks more like debris than something placed by humans, but Spray says these haphazard logs have probably had the biggest impact on flooding in Peebles of all the interventions they have trialled. "You wouldn't think it looking at them, but they're such an easy and straightforward solution to cutting flood risk."

UPPER: COLIN MCLEAN; LOWER: TERRANCE OBENG





At Lake Wood (above), bends have been reintroduced to Eddleston Water to see how it affects flooding. Right: Chris Spray shows Jason Arunn Murugesu before and after plans of the re-meandered river

Beyond looking at flood risk, the team has quantified the monetary gains of its interventions. "Money talks," says Spray. The researchers say that NFM has helped avoid £950,000 worth of flood damage in the 10 years since the first interventions were installed in 2012. But this is outweighed by the ecological benefits to the region, such as improved carbon storage and increased water quality, which the team values at around £4.2 million. "This is what natural flood management can do that simply building flood defences cannot," says Spray.

Yet natural labs come with their own problems. Spray says the lab's experiments are often a compromise with the dozens of landowners in the area, rather than perfect science. Re-meandering takes a lot of space and farmers may have other plans for that land, says Spray, so the team's efforts have been scaled down from the ideal. "If the landowner doesn't want it to happen, it doesn't happen," he says. "We don't push our luck."

For NFM to work across the UK, river managers need to foster relationships with landowners, says Spray. But that is easier said than done. "We've been here for over a decade," he says. "The trust has been hard fought for."

One solution is to pay landowners to use NFM, something the UK government is planning to do as part of its post-Brexit farming reforms, although details haven't yet been published. Spray hopes this will help increase the take-up of his team's research. "These techniques only work if you get farmers on board – you need to make it worth their while," he says. ■

Animal behaviour

Ultrasound pulses trigger a state like hibernation in mice and rats

Michael Le Page

ZAPPING part of the brain with focused ultrasound can put mice in a hibernation-like state called torpor for at least 24 hours. The same approach can also induce the state in rats, which, unlike mice, don't naturally enter torpor.

"That has huge implications," says Hong Chen at Washington University in St. Louis, Missouri. "Maybe we can scale up the technology to larger animals."

If torpor can be induced in people, it could be useful in medical situations, such as to limit damage when people have had a stroke, says Chen. It may also have potential for suspended animation for space travel.

Many warm-blooded animals lower their body temperature and slow down their metabolism to save energy, entering torpor. Some bats and birds do it at night. Others, such as mice, can enter it when food runs low. Hibernation involves extended periods of torpor with occasional returns to normal body temperature.

In 2020, two teams discovered that stimulating part of the hypothalamus in the brains of mice can induce torpor. However, they used complex methods, including genetic engineering, to activate this "brain switch".

Chen wondered if ultrasound could be used instead. Her team has found that a 10-second pulse of ultrasound focused on the brain switch area in mice led to their body temperature falling by about 3°C (5.4°F). The mice recovered after 2 hours, but by delivering pulses whenever their body temperature started to rise, it was possible to keep the animals in this state for 24 hours with no sign of ill effects (*Nature Metabolism*, doi.org/kb8j).

It may be possible to maintain the state for much longer, says Chen, but her team hasn't yet tried.

While the technique also works in rats, their body temperature only fell by around 1.3°C (2.3°F).

"Although modest, this is important because rats are non-hibernators and, in this, closer to humans," says Matteo Cerri at the University of Bologna in Italy, whose team has induced torpor in rats and pigs by chemically inhibiting a part of the brainstem.



SIMON PHILLPOTTS/ALAMY

A common dormouse in a state of torpor, when metabolism slows down

Lowering body temperature with ultrasound could be useful in medicine, but readying people for extended space travel may require more robust ways to suppress metabolism, says Cerri.

How the ultrasound induces torpor isn't clear, says Takeshi Sakurai at the University of Tsukuba in Japan, whose team was one of the two that discovered the hypothalamus switch.

It might trigger this brain switch, says Sakurai. "However, there are also other groups of neurons in the nearby region that play a role in thermoregulation."

Chen thinks local heating and movement induced by the ultrasound trigger a process that activates the neurons.

Any potential human uses are a long way off, she says. "Safety is a big concern." Focused ultrasound that is too intense or maintained for too long can damage the brain, and her team did many tests to work out a safe dose in a mouse. ■

Environment

Compostable plastic fails to break down after a year at sea

A COMMON plant-based plastic marketed as compostable has been found not to degrade when it ends up in the ocean, remaining intact for more than a year.

Compostable "bioplastics" have been touted as a solution to plastic waste, which enters the ocean at the pace of 12 million tonnes per year. A leading alternative to traditional oil-based plastics is polylactic acid (PLA), a plant-derived material used in clothing, single-use cups and containers. PLA can be composted in industrial facilities, but what happens in the ocean wasn't known.

To find out, Sarah-Jeanne Royer at the University of California, San Diego, and her colleagues compared how materials aged both at the ocean's surface and suspended 10 metres below in a fine-mesh cage. They used palm-sized swatches of textiles made from oil-based plastics, bioplastics like PLA and natural materials like cotton. Each week, they checked the samples, which were next to a pier in La Jolla, California, and assessed a small portion of each swatch visually and chemically.

After 14 months, the PLA samples were as intact as oil-based plastics like polypropylene and polyethylene terephthalate (PET). But natural materials like cotton-based fibres completely decomposed in about a month.

The team also mirrored the experiment in the lab with seawater and bacteria to mimic the natural environment. Neither the PLA nor the oil-based fabrics released carbon dioxide gas, confirming they weren't chemically breaking down (*PLoS One*, doi.org/gr9b9h). "They didn't degrade at all," says Royer.

14

After this many months at sea, bioplastic still wasn't biodegrading

The take-home message, says Frederik R. Wurm at the University of Twente in the Netherlands, is that "biodegradation always needs to consider the end-of-life scenario".

Descriptors like "biodegradable" can be misleading, says Royer. "Consumers in general are not aware of what they are buying." ■

Corryn Wetzel

Health

Does covid-19 affect pregnancies?

The coronavirus has been linked to adverse pregnancy outcomes, but vaccines help to keep mothers and babies safe, reports **Michael Marshall**

BEING pregnant at the height of the covid-19 pandemic was profoundly challenging. Many had to give birth without their partners present and new parents found themselves locked down with little or no outside support.

On top of this, there was the fear of covid-19 itself. At the start of the pandemic, we had hardly any information about how the infection affected pregnancies or newborns. But, three years on, we have a much clearer picture – and it particularly supports vaccination.



ANTHONY WALLACE/AFP VIA GETTY IMAGES

A pregnant woman walking in Hong Kong in March 2020

Pregnancy risks

The pandemic has undoubtedly had negative consequences for pregnancies. A 2022 US study followed 1.6 million pregnant people across 463 hospitals, with half of the pregnancies occurring during the pandemic and the rest in the year before it began. Maternal death rates were higher during the pandemic, at 8.69 fatalities per 100,000 pregnancies, compared with 5.17 per 100,000. A statistical analysis suggests this wasn't a chance finding.

A study published in January compared 115 babies born before the pandemic with 115 infants born to mothers who had covid-19 while pregnant. Thirteen of the pandemic babies didn't reach developmental milestones expected between 6 and 8 months of age, compared with none of the pre-pandemic babies. Whether the negative outcomes were due to the virus itself, the experience of being pregnant and giving birth during a pandemic or other factors isn't entirely clear. "We were fighting an enemy we'd never seen before and we didn't have too much time to think about it," says Alessio Fasano at Harvard Medical School.

We now know that pregnant people are no more likely to catch the SARS-CoV-2 coronavirus than anyone else, but, if they do, there can be extra risks. A 2022 review compiled 435 studies on almost 3.2 million women with covid-19. Those who were pregnant or recently pregnant were more likely to be admitted to intensive care and given invasive ventilation than the other women.

8.69
Maternal deaths per 100,000 pregnancies during the height of the covid-19 pandemic

5.17
Maternal deaths per 100,000 in the year before covid-19 emerged

89%
Vaccines' effectiveness against covid-19 hospitalisations when given during pregnancy

Several systematic reviews also suggest covid-19 is associated with a higher risk of adverse pregnancy outcomes. One review of 42 studies included 438,548 pregnant people, finding that infection during pregnancy was linked with higher risks of pre-eclampsia, preterm birth and stillbirth. A 2022 study of 3545 women in the UK found that infection during the first trimester was associated with a higher risk of miscarriage, at rates of 14 per cent among women who self-reported being infected, compared with 8 per cent for those who didn't.

However, while rates of stillbirth, for example, may be higher with SARS-CoV-2, they are still low overall. In one analysis, there were six stillbirths in 1000 pregnancies in people who didn't have covid-19, compared with 13 stillbirths per 1000 pregnancies in people who had covid-19.

For preterm birth, infection timing seems to be key. A 2022 study found catching SARS-CoV-2 in the first 27 weeks of pregnancy wasn't associated with premature birth, but the risk rose sevenfold if infected after 34 weeks.

Overall, the third trimester seems to be the riskiest, "probably because the heavily pregnant uterus compresses the lungs more than in early pregnancy", says Asma Khalil at St George's University Hospital in London.

When it comes to preterm births specifically, there is no evidence that the virus itself is to blame, with any increased risk probably being due to medical intervention, says Khalil. "When the mother is unwell, doctors are more likely to deliberately deliver the baby early, so its mother can be treated more effectively."

The good news is that covid-19 vaccines are effective during pregnancy. A 2022 review

compiled evidence from 25 studies and found "overwhelming support" for vaccinating during pregnancy to reduce the risk of infection and severe illness.

In a 2021 study, researchers led by Ran Balicer at the Clalit Research Institute in Tel Aviv, Israel, compared 10,861 pregnant women who were vaccinated during pregnancy with 10,861 unvaccinated pregnant women. None had previously had covid-19. Among vaccinated participants, the shots were 96 per cent effective against infection, 97 per cent against symptomatic infection specifically and 89 per cent against hospitalisation.

Support for vaccines

Vaccinating also has benefits for the fetuses, reducing the risk of stillbirth by 15 per cent, according to a 2022 review led by Khalil. Its protection can also be transferred to newborns. A study in March found that vaccination during pregnancy reduced a baby's chances of infection by covid-19 during their first six months of life.

Alongside the vaccines' effectiveness, they have also been shown to be safe. In two 2022 studies, Deshayne Fell at the Children's Hospital of Eastern Ontario, Canada, and her team tracked people who were vaccinated while pregnant. In one study, they followed 97,590 people who gave birth between December 2020 and September 2021, almost a quarter of whom received at least one vaccine while pregnant. These participants weren't at an increased risk of negative pregnancy outcomes, such as haemorrhaging or being admitted to a neonatal intensive care unit.

In the other study, the team followed 85,162 births. Just over half of the pregnant individuals received a vaccine during their pregnancy, with no increased risk of preterm birth or stillbirth.

Despite the vaccines' benefits, there is a debate over whether to offer pregnant people booster shots. A 2023 study showed these produced strong antibody responses in pregnant women. Meanwhile, in a study in February, Sarah Jorgensen at the University of Toronto and her colleagues found that a third vaccine during pregnancy gave infants additional protection against the dominant omicron variant.

"At the start of the covid-19 pandemic, we were fighting an enemy we'd never seen before"

In countries such as the UK, US and Australia, pregnant people are encouraged to get vaccinated against SARS-CoV-2, but there are no programmes offering covid-19 boosters during pregnancy.

Since the covid-19 vaccines were first introduced, debates over whether to offer them at all during pregnancy have been fraught, leading to poor communication and confusion. In 2021, Khalil and her colleagues found that less than a third of eligible pregnant women accepted covid-19 vaccinations. A review published in February 2023 found that pregnant women were still less likely to accept the vaccine than non-pregnant women.

Pregnant people have undoubtedly been harmed as a result. In February 2022, data from six European countries showed that severe covid-19 in pregnancy was "almost exclusively limited to unvaccinated women".

Earlier in the pandemic, physicians weren't sure whether vaccinating during pregnancy was for the best, says Jorgensen. However, that wasn't unique to covid-19. Pregnant people are often excluded from clinical trials, making the safety and efficacy of new drugs and vaccines in these individuals unclear. In a 2021 study, Jorgensen and her colleagues examined 376 trials published between 2017 and 2019: only 5.3 per cent included pregnant people. Amid covid-19, Harriette Van Spall at McMaster University in Ontario, Canada, wrote in a paper that excluding these participants from vaccine trials was "a missed opportunity".

Granted, working with pregnant people is sensitive, says Katie Long at King's College London. But the result seems to be lower uptake of life-saving vaccines. ∎



SALIH ZEKI FAZLIOGLU/ANADOLU AGENCY VIA GETTY IMAGES

A baby after it was born in a hospital in Istanbul, Turkey, in May 2020

Can SARS-CoV-2 infect a fetus during pregnancy?

Early in the pandemic, researchers wondered whether the coronavirus could cross the placenta to infect the fetus. Initial reports suggested it couldn't, but towards the end of 2020, Katie Long at King's College London and her colleagues noticed bleeds in the brain cortices of fetuses, using samples from aborted pregnancies. "We found that haemorrhages were always associated with the presence of SARS-CoV-2 in that fetal brain tissue," she says. They concluded that the virus crossed into the fetuses, weakening the blood vessels in their developing brains.

It was a dramatic finding, but we don't know if the bleeds were harmful to the developing fetuses. There was no sign in the clinical records that covid-19 was a factor in the terminations.

Nevertheless, a study in April from another group reported two newborns with seizures and brain damage whose mothers had SARS-CoV-2 towards the end of their pregnancies. When one of the babies died at 13 months old, evidence of the virus was found in their brain.

Overall, it is considered rare for the virus to cross the placenta. Most babies born to mothers with covid-19 don't test positive for it, says Asma Khalil at St George's University Hospital in London.

News

Zoology

Migrating bats use Earth's magnetic field to navigate

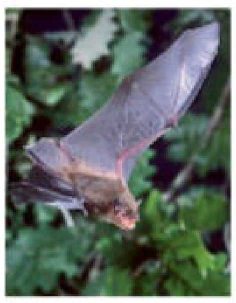
Richard Kemeny

BATS use a magnetic sense to help them navigate long distances.

Many animals may use Earth's magnetic field to orient themselves or to navigate, including turtles and birds. Until now, there has been no direct evidence that migratory mammals use this sense, called magnetoreception.

Migratory bats travel hundreds or thousands of kilometres each year. As nocturnal voyagers, they can't rely on seeing landmarks, and echolocation only works over tens of metres. So William Schneider at Bangor University, UK, and his colleagues wondered whether bats were navigating via magnetic field.

They trapped 65 soprano pipistrelles (*Pipistrellus pygmaeus*) on their migration route in Latvia. Just before sunset, the researchers manipulated the magnetic field around two groups of bats using a device called a Helmholtz coil.



WILDCHROMES/ALAMY

Soprano pipistrelle bats migrate huge distances, using magnetic fields to help guide them

One group had a 120-degree clockwise horizontal shift in polarity, which lets animals orient themselves with the poles; the other had this plus a shift in inclination of the magnetic field lines, as if the bats were in the southern hemisphere.

When the researchers released the bats, those exposed to only the horizontal shift took off to the north, supporting the idea they can detect the magnetic field. The bats exposed to two shifts took off in all directions, indicating that they are sensitive to the field's vertical inclination too – and were probably very confused (bioRxiv, doi.org/kb9s).

Analysis Artificial intelligence

Who will control AI-created 'digital twins'?

Negotiation over the use of AI between the US actors' union and Hollywood studios could determine the viability of acting as a career, finds **Jeremy Hsu**



JOSE PEREZ/BAUER-GRIFFIN/GC IMAGES

Mark Ruffalo at the Writers Guild of America strike in New York on 23 May

ACTOR Tom Hanks speculated in a recent interview that artificial intelligence could one day recreate him on screen, keeping his likeness performing long after his death. "I could be hit by a bus tomorrow and that's it, but my performances can go on and on and on... Outside of the understanding that it's been done by AI or deepfake, there'll be nothing to tell you that it's not me," said Hanks.

The use of AI to create such "digital twins" or clone an actor's voice is set to become a key point in discussions between Hollywood studios and the union representing US actors and performers. The Screen Actors Guild and the American Federation of Television and Radio Artists (SAG-AFTRA) is set to start negotiations with the Alliance of Motion Picture and Television Producers on 7 June.

At stake is who will retain control over digital doppelgängers used in film and television. If studios gain sole control over the rights to an actor's likeness, they could potentially use the digital twin in any number of sequels and spin-offs without paying actors or even getting permission.

"An actor might find that they have lost control of their digital twin, who now gets more work than the original actor, without any compensation flowing to the original actor," says Ryan Meyer at US law firm Dorsey & Whitney.

Studios have already used AIs to modify or enhance existing performances. For example, AI has placed new lips speaking different languages onto the face of an actor who never spoke those words. It has also improved de-ageing visual effects by erasing "decades from Harrison Ford in the upcoming *Indiana Jones and the Dial of Destiny*", says Meyer.

> **"Less established actors might have to compete against digital versions of dead stars"**

Some projects are already using AI to keep actors' performances going. James Earl Jones has retired, but he approved the use of his AI-replicated voice in future *Star Wars* content that may require the iconic rasp of Darth Vader.

SAG-AFTRA declared in a 17 March statement that studios must bargain with the union for use of AI and "digital doubles". The union's 160,000 members – including actors, extras, voice actors, broadcast journalists, dancers and DJs – are voting on a referendum authorising the union to strike if negotiations fail. The voting period closes in early June.

The ongoing Writers Guild of America strike by Hollywood writers has already shut down some film and show productions in Los Angeles and New York City, but a strike by SAG-AFTRA members would shut down almost everything else in production, says Kate Fortmueller at the University of Georgia.

Meyer says a best-case scenario for performers would be an agreement on AI-related rights that applies across the board – from background extras to leading stars. Another possible aim would be to restrict when AI-generated actors can be used, to ensure human actors have work.

Even if today's performers maintain some AI-related rights, "less established actors might have to compete against generations of digital versions of famous actors long after the original actors have retired or passed away", says Meyer.

The worst-case scenario would leave individuals to negotiate without a collective agreement. That would affect most SAG-AFTRA members, who lack the star power to negotiate favourable terms – and could make it hard for aspiring actors to get work.

"I don't think we need to worry about Tom Cruise," says Fortmueller. "But how does one become Tom Cruise in 20 years?"

LAST CHANCE TO REGISTER

New Scientist
Subscriber Event



ONLINE AND IN-PERSON EVENT

THE SEARCH FOR DARK MATTER

7 June, 2 - 3.30pm EDT, Conway Hall, London, and online

Join a leading astrophysicist and a panel of *New Scientist* journalists for a deep dive into dark matter. You'll discover why our current model of the universe needs this mysterious substance to stop galaxies tearing themselves apart. You'll also learn how physicists around the world are striving to detect dark matter directly, including at a laboratory 2 kilometres underground in Canada.

To register your place, visit

newscientist.com/darkmatter

You will need your 12-digit subscriber number which can be found on our customer service and event emails, and above your address on your print copy.

Scan me to register

New Scientist Newsletter



Daily Newsletter

Your daily briefing on the world's most important and intriguing science and technology news.

For a digest on the latest happenings in science, sign up to receive our free daily briefing on the biggest news – and the most inspiring discoveries – direct to your inbox, every week day.

Plus, whether it is the latest in health, space exploration, fundamental physics, our human story or the environment you are interested in, we have a wealth of free weekly and monthly newsletters to suit your tastes.

newscientist.com/sign-up

newscientist.com/newsletter

The Weekly | Business Insights | Fix the Planet | Health Check | Launchpad | Lost in Space-Time | Our Human Story | Wild Wild Life

Physics

Nuclear clocks could be the best timepieces in the universe

Alex Wilkins

THE discovery of an elusive flash of light from the nucleus of the element thorium, which physicists have been hunting for decades, brings us a step closer to building a nuclear clock. This could be the most precise timepiece in the cosmos and help probe our understanding of the universe.

You may have already heard of atomic clocks, which use the energy levels of electrons around a nucleus to tell time – each electron can only have certain, fixed energy levels. Tuning a laser to just the right frequency lets researchers bounce an electron between two of these energy levels. It is this frequency that serves as the tick of an atomic clock, keeping time to an accuracy of only a few lost seconds every billion years.

Atomic nuclei can also jump between different energy levels. In particular, the nucleus of radioactive thorium has an unusually small gap between energy levels that would make for an extraordinarily accurate clock.

Physicists had been unable to identify the precise laser frequency necessary to build such a clock, but now Sandro Kraemer at Ludwig Maximilian University of Munich in Germany and his colleagues have pinned it down.

Ordinarily, thorium is a billion times more likely to emit an electron than a photon of light, but, by embedding the nuclei in a crystal lattice of calcium and magnesium fluoride, the team was able to change the odds. With a greater ability to produce photons, the researchers could measure this flash of light precisely enough to determine its frequency with seven times less uncertainty than previous measurements.

It is this frequency that would be required to fire a laser at a thorium nucleus to make a clock. "Showing that you can control it to such a degree that you can see the signal of photons coming out is a big milestone for thinking about building a nuclear clock," says Kraemer.

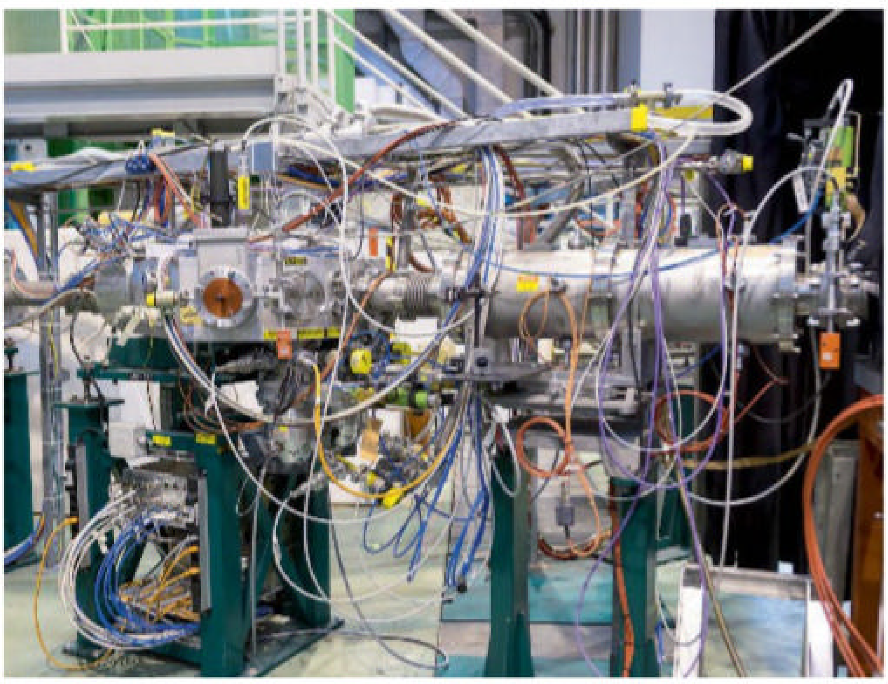
"Showing you can see the signal of photons is a big milestone for building a nuclear clock"

To produce the radioactive thorium, which doesn't occur in nature, Kraemer and his team fired protons into a uranium target at the ISOLDE facility at CERN in Switzerland to produce a beam of radioactive actinium ions. They then fired these ions into calcium and magnesium fluoride crystals, where they decayed into photon-producing radioactive thorium nuclei (*Nature*, doi.org/kb46).

The work means we now know the energy levels of the thorium nucleus almost well enough to build a working nuclear clock, says Kraemer. There are research groups already trying to construct a laser that can excite the nucleus – but the final hurdle might involve years of fine-tuning the frequency to the perfect pitch.

If successful, a nuclear clock could tell us about the inner workings of nuclei and probe for discrepancies in the universe's fundamental forces, as well as improve on already incredibly precise atomic clocks.

"The different feature that it relies on – a nuclear resonance – would make it interesting to compare this nuclear clock with established atomic clocks in order to look for effects of new physics in the quantum domain or in relativity," says Ekkehard Peik at the German National Metrology Institute. The forces that operate on the nuclear scale, such as the strong and weak force, are different from those acting on atomic clocks, so any discrepancy might hint at new physics, he says. ▮



CERN

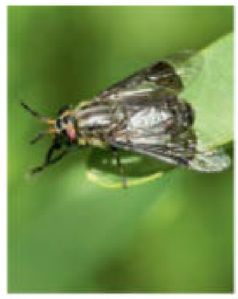
CERN's ISOLDE facility generated radioactive actinium for the study

Zoology

Good way to avoid bite of common insect is to sit still

Brian Owens

IF DEER flies pester you in the woods of North America this summer, don't run away – try sitting quietly. People attract more of the blood-hungry insects while walking than while sitting still.



PAUL REEVES/SHUTTERSTOCK

Deer flies are commonly encountered in forests in the summer in the US and Canada

These flies (genus *Chrysops*) are a major pest for mammals, with their painful bites leading to weight loss and reduced milk production.

Woodland caribou spend more time lying down in June and July, when deer flies are most active, so April DeJong at Trent University in Canada decided to see if that might be a way of minimising bites.

For several weeks, she spent her lunch break as fly bait, either walking along a forest trail or sitting quietly beside it for 20 minutes at a time, wearing a hat with a sticky fly trap on the back.

The trap caught five times as many deer flies when walking versus sitting and the average number of flies caught per minute was also much lower when sitting (*Canadian Journal of Zoology*, doi.org/kb5c). "Sitting was much nicer than walking," she says. "When I was walking, they were always surrounding me and it was difficult not to swat them."

DeJong says the difference is probably because moving exposes you to new flies, while sitting only attracts the ones already nearby.

The technique won't work against all insects, warns Bridgett Benedict at Texas A&M University. Mosquitoes, for example, use smell to find distant meals and staying still may leave you a sitting duck. ▮

Health

Man with paralysis walks by activating brain and spine implants with his mind

Clare Wilson

A DUTCH man who was paralysed after breaking his neck can now walk with crutches after receiving implants that let his brain send signals to his spine through a computer in a backpack.

Gert-Jan Oskam, who is 40, can now stand up from a seated position, go upstairs and walk on uneven ground. "The stimulation will kick in as soon as I think about [taking] a step," he says.

Oskam has also found that even when the device is turned off, he is able to walk short distances with a wheeled walking frame. Grégoire Courtine at the Swiss Federal Institute of Technology in Geneva and his colleagues, who developed the technology, think this may be because the repeated exercise has stimulated regrowth of nerve cells in the spine.

The brain implants sit in two 5-centimetre discs that rest on the brain's surface, having replaced two circles of bone taken from his skull. They communicate wirelessly with a helmet-like receiver, which sends signals to the backpack computer. The computer then sends signals to stimulators put into Oskam's spinal cord, which trigger movements of his leg muscles (*Nature*, doi.org/gr9b5x).

The system is an upgrade on the first version, which Oskam received five years ago, involving only spinal electrodes. With that version, Oskam would make a small heel movement, which he could do because the accident didn't completely sever his spinal cord. Motion sensors detected the movement and caused the spinal implants to trigger a semiautomatic step coordinated by networks of neurons in the lower spinal cord.

"This gave more like a robotic stepping movement," says Courtine. It allowed Oskam to walk on flat ground using a wheeled walking frame.

In 2021, Oskam got the brain implants. Within a few minutes of the surgery, he was able to walk and this has led to more natural movements. "He can adjust when the stimulation is turned on and by how much. It makes the movement very fluid," says team member Guillaume Charvet at Grenoble Alps University in France.

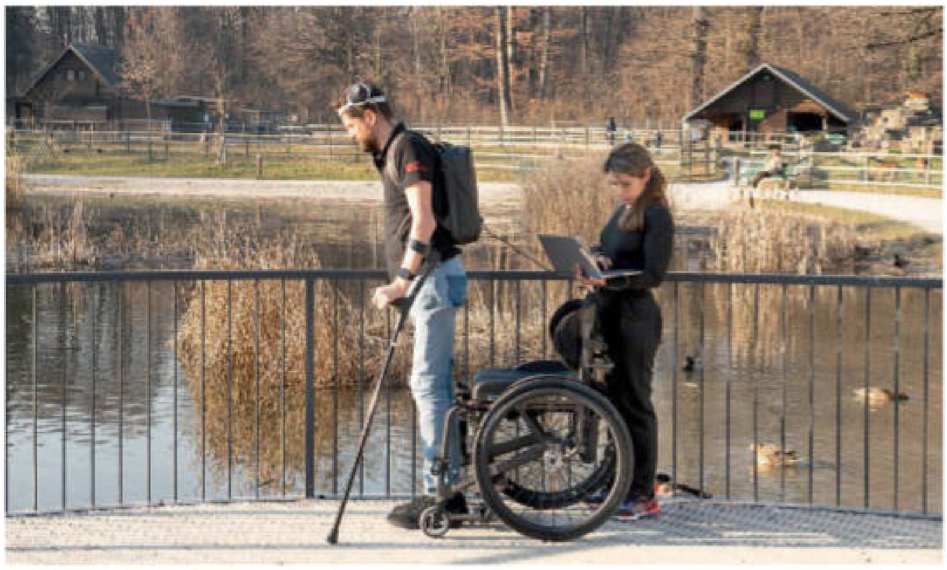
"The stimulation before was controlling me and now I'm controlling the stimulation by my thoughts," says Oskam. The brain-controlled system also leads to a wider variety of movements of the hips, knees and ankles.

So far, nine people have received the spinal implants alone, controlling their motion either by making small residual leg movements, as Oskam did, or by pressing buttons on the walker. Some may now have the upgrade.

The team also has approval to try using the approach to restore arm movements for people who are paralysed from the neck down.

"This is a beautiful piece of work," says Zubair Ahmed at the University of Birmingham, UK. "What's cool about it is they're linking a lot of technologies together." However, the system is still in early development and would be too expensive for wide use in spinal cord injury, he says. ▮

Implants in his brain and spine are helping Gert-Jan Oskam walk



CHUV 2022/WEBER GILLES

Space

Astronomers race to observe rare nearby supernova

A STAR has exploded in a galaxy just 21 million light years from Earth, giving astronomers a rare opportunity to watch a supernova unfold in real time in exquisite detail.

Supernova SN 2023ixf was discovered in the Pinwheel galaxy, or M101, on 19 May by a Japanese amateur astronomer called Koichi Itagaki. It is the closest supernova to Earth since SN 2014J in 2014, which was some 11 million light years away. The new supernova, which already outshines its host galaxy, is expected to peak in brightness in the coming days, but may remain visible for years.

While thousands of supernovae are seen every year, the proximity of 2023ixf means it can be studied in much more detail than others. Telescopes across the world were pointed in its direction "within hours of its discovery", says Azalee Bostroem at the University of Arizona, deducing it is probably a type II supernova, in which a giant star runs out of fuel and collapses in on itself before exploding.

Bostroem has been allocated time on the Hubble Space Telescope to study the ultraviolet light from the explosion. So far, it looks like the supernova is interacting with material that was previously ejected by the star, which the Hubble observations could probe further. "How stars lose mass is one of the most interesting questions," says Bostroem.

Two or three stars have been identified as the possible progenitor of the supernova, including a type of massive star known as a Wolf-Rayet, but the signal is currently too bright to work out which it is. Hubble or even the James Webb Space Telescope could tell us more when the supernova dims.

"This is going to be like a Rosetta Stone supernova – one that we compare everything to"

Observations of 2023ixf may provide invaluable data to inform our picture of how stellar explosions unfold. "This is going to be like a Rosetta Stone supernova," says Bostroem. "It's going to be one of those ones that we compare everything to." ▮

Jonathan O'Callaghan

AN IMPORTANT MESSAGE FROM PROFESSOR NICK LEMOINE CBE MD PHD FMEDSCI, CHAIR OF THE MEDICAL RESEARCH FOUNDATION

Gifts in Wills could be the key to protecting the future of human health

Our experience of COVID-19 shows how suddenly a global health challenge can appear. As someone interested in science, you will understand that while nobody can predict what we will face next, we can be certain that the future will bring many more threats to human health.

As Chair of the Medical Research Foundation – the charitable arm of the Medical Research Council – I have seen the incredible impact that individuals who remember the Foundation in their Wills can have on the future of our health and wellbeing here in the UK. These gifts fund research and researchers which can have far-reaching implications for human health.

With a gift in your Will you can play a key role in providing the science that will protect the health of future generations.

Right now, the Foundation is funding research to tackle antimicrobial resistance, and investing in researchers like Dr Myrsini Kaforou – who will make the fight against antimicrobial resistance her life's work.

Without support at the crucial early stages, researchers like Dr Kaforou can be forced to abandon their passion and leave science altogether, with an immeasurable loss to future human health. Gifts in Wills provide the long term funding and security that allows the Foundation to invest in projects like Dr Kaforou's and lay the foundations for quality research in years to come.

Your Will can fund the rational response to health challenges that medical science provides.

> **"As scientists, our duty is to secure the future of research for the generations that follow."**
>
> Professor Fiona Watt, Patron of the Medical Research Foundation and Director of the European Molecular Biology Organization.

While we don't know what the future holds for human health in the UK, we do know that research, and the brilliant scientists driving that research forward, are the key to meeting those challenges for years to come.



"The funding I received through the Medical Research Foundation will be transformative for my research." Dr Myrsini Kaforou

But many of these scientists rely on the generosity and foresight of fellow members of the public – people like you, who understand the power of science and are willing to leave a gift to medical research in their Wills. At the Medical Research Foundation, over 90% of our voluntary income comes from individuals who choose to include a gift in their Will – they are crucial in the Foundation's ability to fund research that will enable the next generation of scientists to make real world discoveries in the future.

I firmly believe that a gift in your Will to the Medical Research Foundation is an excellent investment and will have a lasting impact on science and on the future of human health in the UK.

Please consider this very special gift today.

Professor Nick Lemoine CBE MD PhD FMedSci
Chair of the Medical Research Foundation

Get your free guide to supporting research in your Will.

Scan this QR code to find out more

To request your free guide to gifts in Wills fill in this form and return to, **MEDICAL RESEARCH FOUNDATION, 99 CHARTERHOUSE STREET, LONDON, EC1M 6HR OR** visit **medicalresearchfoundation.org.uk/support-us/wills**

Name ____________________

Address ____________________

____________________ Postcode ____________

Email address ____________________

Medical Research Foundation

Registered with FUNDRAISING REGULATOR

We would like to contact you from time to time with our latest news. Please tick here ☐ if you are happy for us to contact you via email. The Medical Research Foundation does not share your personal information. You can unsubscribe at any time. For further information on how we collect, store and process your personal data, please read our Privacy Notice medicalresearchfoundation.org.uk/privacy

Medical Research Foundation is a charity registered in England and Wales (Reg. Charity No. 1138223). Please follow Government isolation and distancing guidelines if posting. 1623PBN

Health

Junk food diet may disrupt our slumber

A DIET that is high in fat and sugar may reduce sleep quality by messing with the brain's electrical activity during deep sleep.

Jonathan Cedernaes at Uppsala University in Sweden and his colleagues assigned 15 men to one of two diets for a week. The high-fat, high-sugar diet featured pizza and chocolate, and the low-fat, low-sugar diet included things like salmon and vegetables.

Participants then slept in a lab as an EEG cap recorded their brains' electrical activity. A few weeks later, they switched diet and repeated the process.

People felt their sleep was the same, yet the junk food diet disrupted restorative "slow-wave sleep" by cutting the amount of delta waves in the brain, suggesting it was less restful (*Obesity*, DOI: 10.1002/oby.23787). **Alice Klein**



NIALL FLINN/ALAMY

Environment

Tumble dryers have a microfibre problem

ALL types of tumble dryers release significant amounts of microfibres into the environment, research has revealed, putting fresh pressure on manufacturers to redesign their appliances.

When garments are washed and dried, they shed tiny particles of clothing fibres. Studies have already shown that vented dryers, which release warm, moist air to the outside via an exhaust pipe, pump out large quantities of airborne microfibres.

Now, Neil Lant at Procter & Gamble in Newcastle upon Tyne, UK, and his colleagues have done work suggesting that condenser dryers, which extract water from the moist air and store it inside the appliance, produce similar amounts of microfibre pollution, although it ends up in waterways, rather than in the air (*PLoS One*, doi.org/gr9b9n). **Madeleine Cuff**

Animal behaviour

Gulls choose meals based on what they see people eat

SEAGULLS pay attention to our food choices and show a preference for meals similar to what nearby people are eating.

European herring gulls (*Larus argentatus*), a ubiquitous presence in coastal towns and cities in the UK, are notorious food snatchers – or kleptoparasites, to use the scientific term. "Many people still think that gulls are not very smart, even though kleptoparasitism to us suggested a higher level of cognition, so we wanted to explore this further," says Franziska Feist at the University of Sussex, UK.

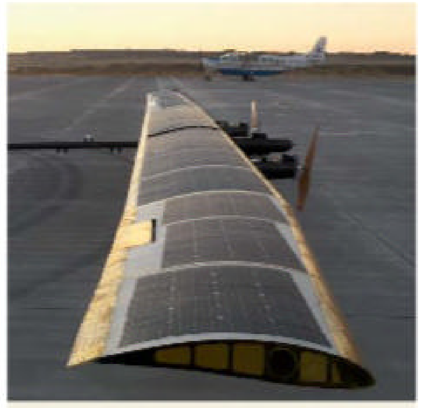
Feist and her colleagues studied gulls on the Brighton beachfront for a few months in 2021 and 2022. They presented blue and green packets of potato crisps to groups of gulls. An experimenter sat on the ground about 5 metres away and either idly watched the gulls or pulled out a green or blue packet from their bag and ate from it.

The researchers found that 48 per cent of the birds approached the packets when the experimenter was eating, compared with 19 per cent when they weren't. When gulls pecked a packet, they chose the same colour as the experimenter's packet 95 per cent of the time (*Biology Letters*, doi.org/kb5h).

"The evolutionary history of herring gulls wouldn't have involved humans, since their urbanisation is rather recent," says Feist. So the social skills that allow them to learn from another species must come from high-level, general-purpose intelligence, she says.

The birds' use of human cues may be problematic, says Madeleine Goumas at the University of Exeter, UK, because the processed foods humans eat may not be good for them. **Soumya Sagar**

Really brief



WENZHU LIU ET AL.(2023)

Bendy solar panels are just as good

New lightweight, silicon-based solar cells are so flexible they can wrap around themselves without losing efficiency (*Nature*, doi.org/kb53). Because they are 95 per cent lighter than rigid cells, they can be used on walls without compromising building integrity, or to power a drone (pictured, above).

Chemicals found in wild primate faeces

An analysis of faeces from baboons, chimpanzees, red colobus and red-tailed monkeys in Uganda's Kibale National Park has revealed 97 chemical pollutants. This means the substances, some of which are known to disrupt hormones, are in their digestive tracts (*Biology Letters*, doi.org/gr9b53).

Nanoscale DNA 'hand' grabs viruses

A nanosale robotic hand with four bendable fingers made from DNA can grasp objects. When extra bits of DNA that bind to the spike protein of the SARS-CoV-2 virus are added to the nanohands, they can "grab" viruses, which prevents them from being able to infect cells (bioRxiv, doi.org/kb5z).



23 March 2024 | 15 days from £11,399 (Approx $14,200)

The science of the deep Antarctic: Shackleton's expedition and the Weddell Sea

Join one of the greatest expedition voyages on this planet. Journey below the Antarctic Circle and deep into the ice-choked Weddell Sea, a part of Antarctica that few get to experience. Encounter huge tabular icebergs, and an array of marine wildlife on this trip of a lifetime to the world's most remote continent.

Exclusive to *New Scientist*, you will be accompanied by marine biologist and author Helen Scales along with a highly knowledgeable and supportive expedition team (experts in exploration, science and wildlife).

Retrace the paths of early British explorer Ernest Shackleton, one of the greatest known survival stories of polar exploration. Hear first-hand from broadcast presenter and producer, Saunders Carmichael-Brown, who was aboard the Endurance 22 expedition that discovered the remains of Shackleton's ship on the Antarctic seabed in 2022.

Travel aboard a new state-of-the-art polar expedition vessel, the Sylvia Earle. With a capacity for just 132 guests, it is large enough to offer luxury and to navigate deep into the ice but remains an intimate and highly personalised experience. With a full programme of talks, shore visits and Zodiac boat safaris.

Highlights

- Experience the enormity of Antarctic ice and enormous tabular icebergs in the Weddell Sea.
- Zodiac cruises in secluded bays and quiet coves filled with brash ice. Photograph enormous glaciers and spectacularly shaped icebergs.
- Learn all about the Antarctic's unique ecosystems from marine biologist Helen Scales.
- See an array of wildlife that frolic, forage and hunt in Antarctic Sound including whales, penguins and seals.
- Uncover the fascinating history of Shackleton's expedition, including the Endurance 22 expedition discovery of the Endurance shipwreck from film producer Saunders Carmichael-Brown.

A full programme of talks whilst at sea including:

- The story of Shackleton and the Endurance.
- The Endurance 22 expedition.
- How to stage deep Antarctic exploration.
- Polar science including how species adapt to survive in such challenging environments, polar research, geology beneath the ice and the importance of Antarctica to the planet's wellbeing.
- Floating and walking seminars surrounded by icebergs and wildlife.
- How to record the best of your Antarctic cruise with onboard photography expert.
- Navigating in polar environments and reading the weather patterns, the ice and the currents.

For more information and to book,
call UK +44 (0)203 196 1000 (UK office: Mon-Fri 9am to 5:30pm GMT)
or visit newscientist.com/tour

Scan me to find out more

New Scientist Events

New Scientist Live

7 – 8 OCTOBER
SCHOOLS' DAY 9 OCTOBER
EXCEL LONDON AND ONLINE

THE WORLD'S GREATEST FESTIVAL OF IDEAS AND DISCOVERIES

What if I can't join in-person?
You can also join us online as we bring you two days of incredible content right to your screen, wherever you are in the world.

More than 50+ talks from across the four event stages on the Saturday and Sunday will be live-streamed and also available on-demand for 12 months afterwards, so if you miss any of the talks or just want to relive your favourite moments from the weekend, you can do so at your leisure.

Find out more
newscientist.com/nslpa



THE UNIVERSE

The Universe Stage is your place to hear about the mysteries of the cosmos. Hear from world-leading scientists about the JUICE mission to Jupiter's moons, the latest results from the James Webb Space Telescope and the quest to photograph a black hole.

MIND AND BODY

The Mind and Body Stage is all about being human. From teenage mental health to growing 'mini brains' in a dish, from psychedelics to the psychology of misinformation, we will reveal amazing research to help you live a happier, healthier life.

OUR PLANET

Our Planet Stage will be your home for all things environmental, from in-depth analysis of the climate crisis to the mysteries of the deepest oceans. We will examine everything from lab-grown meat to the truth about female animals, to reveal the full diversity of life on Earth.

THE FUTURE

The Future Stage is your place to discover the world of tomorrow. From cybersecurity to digital twins, this is the place to explore the innovations that will power the technology of the next decades.

Feature Partners

Schools' Day Partner

Charity Partner

Media Partner

New Scientist
Podcast



The New Scientist Weekly podcast

Our prizewinning show brings you a curated selection of the essential stories of the week.

Hosted by *New Scientist*'s Rowan Hooper and Penny Sarchet. Feed your curiosity, for free, every Thursday. Make your week better with New Scientist Weekly.



Penny Sarchet



Rowan Hooper

Follow us on Twitter **@newscientistpod**

Listen on Apple Podcasts · Listen on Spotify · Listen on Google Podcasts · Listen on Stitcher · YouTube

The columnist **Graham Lawton** digs into the concept of ethical cheese p28

Aperture Poignant shots of a melting glacier in Uganda p30

Letters Is it time we looked further for a solution to the diet crisis? p32

Culture Earth's oceans take centre stage in a new book p34

Culture columnist **Jacob Aron** enjoys a game set in a broken escape pod p36

Comment

It's not easy being green

Amphibians could help cure our ills, from diabetes to fungal infections – if they don't go extinct first, says **Matthew Gould**

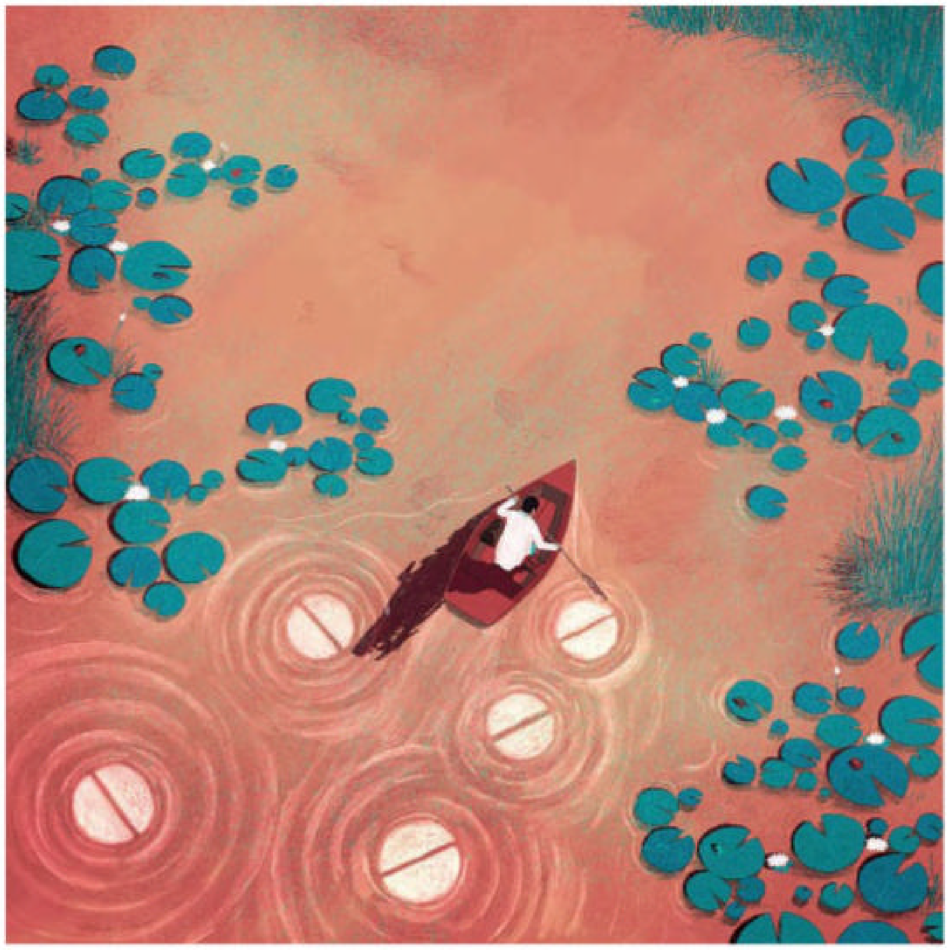
I WAS at university in the early 1990s, when toad licking was the latest drug-related panic. I remember many conversations about it, though I don't remember anyone actually licking a toad, or indeed any other amphibian.

The nearest anyone got to real psychedelic experimentation was an architecture student called Mark, who tried to smoke banana skins. I don't think it worked. But the toad thing hasn't gone away. Only last year, the US National Park Service asked its visitors to stop licking toads because of the effect it was having (presumably on both the visitors and the toads).

It turns out the potential of amphibian secretions goes much further. Research presented at a recent Diabetes UK conference showed that a molecule on the surface of East Asian bullfrogs boosted insulin production in mice, which could be an important development for the 400 million people with type 2 diabetes.

This is only the latest discovery of a prospective medicine from frogs, of which there are more than 7500 species, each with its own collection of potentially useful chemicals. No two species have been found to have the same compounds on their skin.

Skin secretions from several Australian tree frogs have already been shown to inhibit HIV infection. Some work against fungal infections and others have different antimicrobial properties. A compound isolated from the phantasmal poison frog has been shown to have 200 times the painkilling potency of morphine.



SIMONE ROTELLA

Frog foam, a substance some species use to make nests, could be useful as a temporary dressing for wounds and burns. Foam from the túngara frog could help provide a slow-release delivery system for antibiotics.

But there is bad news as well. Amphibians are about the most threatened group of animals on the planet, with more than 40 per cent at risk of extinction. Some of the fastest species declines on record have been of frogs.

For more than 20 years, the Zoological Society of London, the international conservation charity I lead, has been at the forefront of amphibian disease research. In the mid-1990s, alongside partners, our scientists discovered that a chytrid fungus was devastating amphibian populations globally. We have since helped lead efforts to stop this turning into an extinction.

We have discovered that washing frogs in an antifungal bath can buy conservationists more time to implement longer-term protective measures. On Montserrat, our scientists are trialling heated pools for the critically endangered mountain chicken frog. In a nice inversion of the normal boiling frog cliché, warm water kills the fungi without harming the frogs.

Chytrid fungus is just one of the problems causing amphibian numbers to plummet. Even if we learn how to deal with its consequences, amphibian populations are still being decimated by habitat loss, pollution, invasive species and other threats, all of them arising from our own inability to live in balance with our planet.

Though we often try to separate ourselves from nature, we will always end up dealing with the consequences of upsetting its equilibrium. In Central America, for example, declining numbers of frogs have led to an increase in malaria – probably due to there being fewer frogs to act as pest control. And then there are all the potential therapies on the backs of frogs that we might never get to benefit from if they go extinct.

Protecting wildlife isn't a luxury, it is an important part of securing our future. From the myriad benefits of frogs to the carbon-capturing impact of wildebeest and the ocean-purifying work of oysters, we need wildlife to flourish if we are to flourish. So let's not lick any more toads, kids. ▮



Matthew Gould is chief executive of the Zoological Society of London

No planet B

Cheesy does it

I thought there was no way around cheese being an environmental and ethical disaster, but a new approach to dairy farming has proved me wrong, says **Graham Lawton**



Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

A FEW years ago, I wrote a feature story that has become, at least in *New Scientist* circles, the quintessential example of my role as the harbinger of doom. It was about the shocking environmental impact of cheese, especially its colossal methane and carbon hoofprint. The reactions from my colleagues were variations on "I don't want to know".

I am now ready to become a harbinger of good news. Earlier this month, I went to a conference organised by Compassion in World Farming, and others, where I met a farmer called David Finlay. He runs a creamery in Galloway, Scotland, called The Ethical Dairy. I wrote about this enlightened enterprise in my earlier article, but concluded it was unlikely to make a positive impact on methane emissions as the productivity was lower than a conventional dairy. I now cheerfully recant. I can have my cheese and eat it after all.

The distinguishing feature of The Ethical Dairy is that it is a "cow-with-calf" system. Dairy cows need to be constantly calving to produce milk. Conventional dairy farming employs a contentious procedure called calf separation, whereby calves are taken from their mothers soon after birth. The cold logic is that calves drink their mother's milk, which significantly eats into profitability. But it comes at a terrible ethical cost, with evidence that the procedure is distressing for both cow and calf.

Cow-with-calf farming allows calves to stay with their mothers until they are weaned, which can take around 10 months on a beef farm. That is more ethical, but doesn't seem to make economic sense for dairies, as calves drink a lot of milk. Finlay begs to differ.

Twenty-five years ago, he and his wife were running a conventional dairy farm. They later decided they wanted out of the intensive farming system and went organic. But calf separation was still an issue, so they built a new dairy in 2012, designed to house the calves with their mothers, and trialled the cow-with-calf system. Predictably, this wasn't financially viable, as the cost of their milk was uncompetitive.

In 2016, they tried again. They gave themselves three years to either make it work or quit – and they are still in business.

How so? Finlay told me that they no longer have to buy loads of expensive fertiliser, pesticides, antibiotics and feed. The cows live out on the pasture and eat mainly grass, plus the herbs, dandelions and clover the Finlays have let take root, with only a bit of feed. Cows that suckle their calves can produce 25 per cent more milk than intensively farmed ones, partially offsetting the 40 per cent guzzled by the calves. In addition, naturally fed calves wean early, at around 6 to 8 months, at which point the females join the dairy herd. This increase in productivity and head count allows the Finlays to produce 95 per cent of the milk they used to, with much lower input costs.

> **"Cows that suckle their calves can produce 25 per cent more milk than intensively farmed ones"**

There are added benefits too. The cows are happier, healthier and live longer than cows in a conventional dairy farm, which are typically slaughtered before they are 7 years old.

The soil is better, increasing its organic matter content from 11 per cent to 14 per cent. The Finlays have also cut the use of artificial chemicals and antibiotics by 90 per cent, and fertilise with composted manure. Biodiversity is five times as high as it is on an average dairy farm.

Best of all, the farm is an accredited carbon sink, even accounting for the methane belched out by the cows, largely because of the increase in soil health. Dandelions, in particular, sequester a lot of carbon. And they are delicious to cows.

The milk is still a bit pricier than that from intensive farming, but not by much. And in any case, they use it all to make cheese. The Ethical Dairy produces five different cheeses, and they are delicious to humans. Not cheap, mind – a selection pack of all five costs £37. Bog-standard cheddar costs about a fifth of that. But bog-standard, the Finlays' cheese ain't.

However, not everything is idyllic down on the farm. Finlay has faced pushback from his suppliers, dairy farmer neighbours and even local politicians, who assumed he would reduce productivity and cut jobs (he hasn't). Weaned male calves are sold for beef, and dairy cows at the end of their productive lives follow them to the slaughterhouse. Finlay says that if there were a local sanctuary for retired dairy cows, he would send them there. But there isn't.

Nonetheless, The Ethical Dairy proves that cheese needn't be an environmental and ethical disaster. I have tried to quit eating dairy, but failed. I tried plant-based alternatives, but baulked. I can now buy The Ethical Dairy's cheese at an organic supermarket a few kilometres from my home and eat it with my head held high. My wallet will be lighter, but so will my conscience. ■

Graham's week

What I'm reading
Selling Hitler *by Robert Harris, a rollocking account of the Hitler Diaries hoax.*

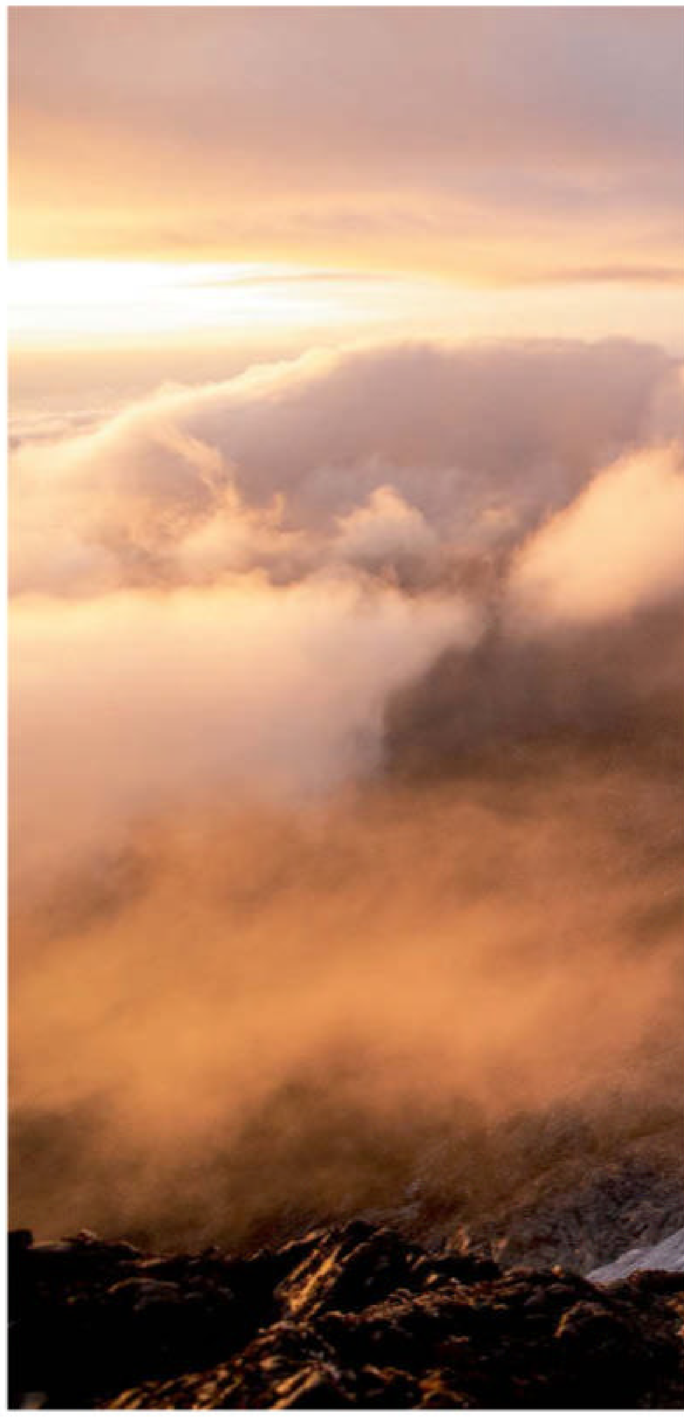
What I'm watching
Black Ops *on BBC One. Daft, dark comedy.*

What I'm working on
Organising a trip to the Democratic Republic of the Congo to visit a pioneering conservation project.

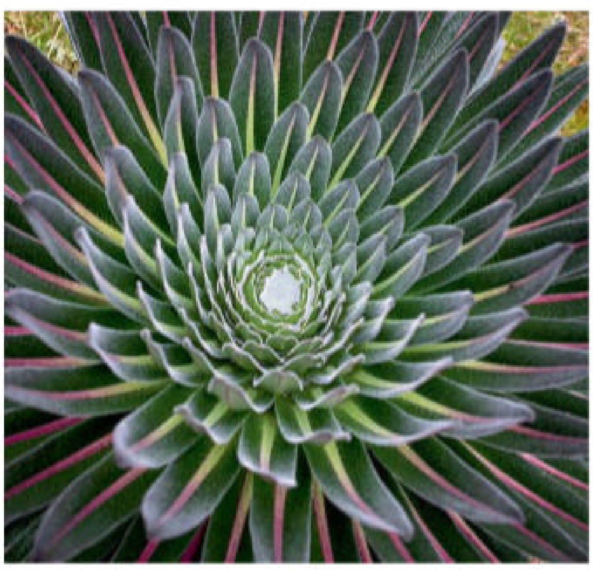
This column appears monthly. Up next week: Annalee Newitz


MANCHESTER
1824
The University of Manchester
BREAK
THROUGH
The University of Manchester's research beacons are tackling some of the biggest questions facing the planet.
Get in touch for knowledge, evidence and expertise:
manchester.ac.uk/beacons
Research beacons
GLOBAL CHALLENGES
MANCHESTER SOLUTIONS





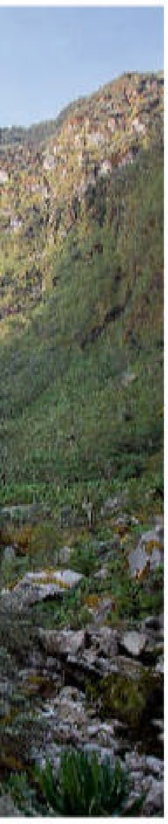














Equatorial ice

AFRICAN glaciers are some of the fastest-melting on the planet. On Mount Kilimanjaro in Tanzania they could be gone by 2040, while those of Mount Kenya and the little-studied Rwenzori mountains that span Uganda and the Democratic Republic of the Congo may vanish this decade.

Their loss will deprive scientists of critical ice cores recording the mostly undocumented climatic history of equatorial Africa, and could drive rare plant and animal species to extinction in these unique ecosystems on the mountain slopes.

Together with my wife and fellow journalist, Alessandra Prentice, I spent eight days hiking in the Rwenzoris to photograph some of the glaciers in this range before they disappear.

The main image shows sunrise over the retreating Stanley glacier, huddled in the valley between the peaks of Margherita (the third highest point in Africa at 5109m) and Alexandra, which form part of Mount Stanley. Photos from 1906 show thick ice covering the tops of the range, but glaciers now cover less than 1 square kilometre. To get to this location, we hiked for six days, sometimes slipping into the knee-deep mud of the Rwenzoris, which means "the rainmaker" in the local language, Konjo.

The remaining images show, clockwise from bottom right: the melting nose of the Stanley glacier; a giant *Senecio*; guides Enock Bwambale (left) and Uziah Kule from Rwenzori Trekking Services; the giant rosette of a lobelia; a porter carrying supplies through the giant heathers of the Rwenzoris; Bwambale and Prentice on the Stanley glacier.

John Wendle

Editor's pick

Time to widen the hunt for solution to dietary crisis

29 April, p 46

From Sieglinde Kundisch, Umeå, Sweden

I was very excited to see the interview with Chris van Tulleken about ultra-processed foods. It is a topic that I spend a lot of time thinking about and is very important if we want to take charge in the obesity crisis.

I welcome his clear words about what ultra-processed foods mean for us. Unfortunately, in this regard there seems to be no regulation about what the food industry can serve us.

I do think that he wasn't clear enough (as a scientist, he was probably understandably cautious) about what it takes to change things. I say bring historians and anthropologists into the discussion. Why was it possible for people 50, 60 or 100 years ago to cook a meal every day while working 40 hours a week or more? And no, not because of housewives – there are plenty of places where both parents worked back then (and often had more children to feed).

We need a shift in our societies about what we value and what we want to do with our time. We need to bring back cooking lessons in schools. There are generations out there that don't know how to cook, but they can learn (to love) it.

Maybe a dose of rule by logical AI is what we need

Letters, 20 May

From Barry Cash, Bristol, UK

I don't understand why people are worried about artificial intelligences taking over. The dinosaurs lasted 165 million years. The first "upright apes" evolved only 5 million years ago and *Homo sapiens* didn't arrive on the scene until about 300,000 years ago.

We have only a few thousand years of recorded history. It isn't a great record. Our world is run by men with an insatiable lust for power and/or an insatiable greed for money. Despite the warnings of science on climate change, they continue to trash our only planet. The human race will be lucky if it lasts another 1000 years.

But a government run by AI would be like Mr Spock: completely logical. Isn't that the best hope for preserving humanity?

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK

The number of pieces on AI seems to be on the increase, especially those that warn of possible dangers. But all these appear to treat AI as though it were a sentient entity already, busy plotting and planning the downfall of humanity.

The truth is that AI, even in its most advanced form, is merely a collection of circuitry that must be built by people and then have someone take the positive decision to turn its power on.

It would be a step forward if future articles could be directed more towards the – mostly profit-seeking – motivations of the humans in the loop.

Fathoming human behaviour is hard

Letters, 13 May

From John Hastings, Whittlesey, Cambridgeshire, UK

Peter Cundall thinks that there is no puzzle that can't be solved by human intelligence. However, there is one that has defeated it: human nature.

If intelligence could solve human nature, we would have begun reducing greenhouse gas emissions 30 years ago and might now be at net zero. We wouldn't just be listening to and applauding Greta Thunberg, we would be doing what she tells us. Our governments would be working seriously to prevent climate change instead of being half-hearted about it.

New wave of chatbots shouldn't be for profit

13 May, p 13

From Sean Barker, Matlock, Derbyshire, UK

My hypothesis is that ChatGPT's output is a form of statistical plagiarism, using the words most probably occurring in its training texts. The only reasonable conclusion is that commercial exploitation of such technologies could be akin to theft of intellectual property, and that such systems should only be made available via not-for-profit firms.

As pressure grows, so will demand for online therapy

15 April, p 38

From Margaret Wilkes, Perth, Western Australia

You correctly point out that the biggest determinant of outcomes in therapy isn't the type used, but the relationship between the therapist and the individual. This raises an interesting point about the relative effectiveness of face-to-face and online therapy.

With growing demand and not enough therapists, the need for online therapy is likely to increase.

Phonics still has plenty going for it

22 April, p 42

From Greg Brooks, Sheffield, UK

Colin Barras believes that the reason why some children in England fail to learn to read adequately is too much phonics. My article "Current Debates over the teaching of phonics", published in the *Oxford Research Encyclopedia of Education* in 2022, provides copious evidence for two main conclusions: systematic phonics teaching is effective for teaching children to read and spell in English, and the combination of systematic phonics teaching and whole language teaching is probably more effective than either alone.

Dark matter and energy could be red herrings

8 April, p 36

From Greg Tanner, Melbourne, Australia

I enjoyed your recent guide to the quantum realm. However, I continue to doubt the existence of dark energy and dark matter.

That we have been unsuccessfully searching for these for many decades and haven't found something that supposedly accounts for 95 per cent of the stuff in the universe suggests to me that they are red herrings.

There are other explanations for the fact that galaxies don't fling themselves apart, which is said to point to the existence of dark matter. The simplest of these is that numerous small and large black holes may provide the necessary missing mass.

If physical laws evolved, why are they just right?

25 March, p 38

From Derek Bolton, Sydney, Australia

Thomas Hertog likens the evolution of physical laws to Darwinian evolution, with "quantum observation" playing the role of selection. He allows such observation to include interactions between particles, though how it causes a collapse of the wave function instead of an entanglement isn't explained. But the key missing argument is how such selection favours a set of laws conducive to the evolution of life.

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed

New Scientist
Book Club

New Scientist Book Club

Join us in reading and discussing the best new science and science fiction books

Be part of the *New Scientist* Book Club and join a community of like-minded readers. Each month, we will delve into an exciting new book. This month, read *The Ferryman* by Justin Cronin. Have the opportunity to put your questions to the author, share your thoughts with us, and more.

Sign up at
newscientist.com/bookclub

Follow us and get involved on Twitter, Facebook and Instagram using the hashtag **#NewScientistBookClub** or email bookclub@newscientist.com

Earth's beating blue heart

A book that casts the ocean as an extraordinary giant engine helps us grasp its complex physics and its key role in climate change, finds **Graham Lawton**



NATALIE FOBES/GETTY IMAGES

We often don't appreciate the ocean's effect on the workings of our planet

Book

Blue Machine: How the ocean shapes our world
Helen Czerski
Torva

WHEN you stand next to the ocean, it is easy to forget that it is connected to every other bit of blue on the planet. If you were so inclined, you could sail from your nearest port through every sea and ocean on Earth without ever making landfall. As ocean physicist Helen Czerski reminds us in her fascinating book, *Blue Machine*, the ocean is huge, covering 71 per cent of Earth's surface and containing 96 per cent of its water.

But what we often fail to appreciate is how vastly important it is for the workings of the rest of Earth's systems, including its atmosphere, ice, land and life. We have a view of our home planet that is still dominated by land and that largely regards the oceans as the salty, wet bits in between.

This is, of course, not a new observation. Photographs from the Apollo missions of the late 1960s and early 1970s had a profound impact on our view of the planet, inspiring the famous quote-cum-cliché: "how inappropriate is it to call this planet Earth when it is quite clearly ocean". (Czerski avoids this, probably in the knowledge that, although it is usually attributed to science fiction writer Arthur C. Clarke, nobody can definitively point to where or when he said it.)

But, in Czerski's hands, the incredible reality of Planet Ocean really comes alive. Much writing about the mysteries of the deep focuses on its weird and wonderful biodiversity, yet it turns out that the physics of the ocean is just as fascinating. And, while Czerski does throw us plenty of biology bones, this is really a book about the ocean's physical features – submarine mountains, volcanoes and waterfalls, deep ocean trenches and the endless abyssal plains – as well as the vast forces that shape the water above them.

Chief among these forces is the heat from the sun, but its light is also involved, as is the rotation of Earth and the salinity and density of the water. Czerski explains how these combine with each other to create a dynamic system that she calls the "blue engine".

It wasn't immediately obvious to me what she meant, but Czerski explains that the ocean does what any engine does: it converts one form of energy, usually heat, into movement.

"This book is about the ocean's physical features, as well as the vast forces that shape the water above them"

And that engine has a profound impact on the whole planet, including dry land. It controls the weather and climate, provides terrestrial species with food and other resources and creates a life-saving buffer against the wild swings of temperature between night and day and across the seasons. The ocean is, she says early on, "the story that defines planet Earth", and she really makes good on that statement.

Czerski has a lovely way with words and a knack for a vivid simile – the great ocean basins, she says, can be thought of as a bit like "the hollows in the trays that used to be used for airline food".

She also knows when to add interesting anecdotes. Did you know that if you cut yourself more than 10 metres underwater, the blood appears green? Czerski does – now. And then there are stories going back to the peopling of the Americas 26,000 years ago.

I also loved the section about Antony and Cleopatra's final defeat by Roman emperor Octavian at the Battle of Actium in 31 BC. Various ideas have been put forward as to why their fleet didn't carry out its battle plan, but the most likely explanation is "dead water" – a phenomenon, caused by the layering of ocean water, that can stop a ship in its tracks. On such oceanic behaviour, history can turn.

The framing of the ocean as an engine driven largely by heat is also a clever device for discussing the impact of climate change, which is, after all, says Czerski, "the slow accumulation of extra energy into the Earth system", 90 per cent of which is absorbed by the ocean.

You can't inject that much energy into an engine without revving it, and the ocean is now showing signs of veering out of control. But there are solutions – and, according to Czerski, they start with appreciating the ocean for what it is, "the beating heart of planet Earth".

Stupid but smart

Being a genius won't stop you staring at an eclipse or letting an argument keep you from finding a planet, finds **Richard Lea**

Book

The Limits of Genius

Katie Spalding

Hachette

HOW is Donald Trump like Isaac Newton? Mathematician and science writer Katie Spalding says that both were stupid enough to stare directly at the sun. The former US president and self-described "very stable genius" may have ignored an aide shouting "Don't look!" during a 2017 eclipse, but the man who discovered the inverse-square law spent much of 1666 "doing just about anything to blind himself", she writes.

In *The Limits of Genius*, Spalding describes how Newton investigated afterimages – images of something that remain visible after the original stimulus is gone – by poking himself in the eye with a huge needle and then looking repeatedly at the sun and into a dark corner, until he had to shut himself in his chamber for three days to recover the use of his eyes. It is no surprise that he had trouble for months afterwards, she writes, since the only thing more stupid than "staring directly at the Sun is to dilate your pupils first".

In *The Limits of Genius*, Spalding creates 30 brief portraits of the great and the good, focusing on their "weird little adventures" and leaving their achievements mostly to one side. We hear how Pythagoras may or may not have been killed by an angry mob when he refused to run through a field of beans, and how Benjamin Franklin liked electrical pranks so much that he knocked himself out electrocuting a turkey in front of his dinner guests.

We discover that mathematician John Couch Adams was so annoyed with the UK's Astronomer Royal, George Biddell Airy, that the pair missed out on the discovery of Neptune, and how Albert Einstein was "known across the Eastern Seaboard for his nautical mishaps" even though he couldn't swim.

Spalding casts her net wide for people smart enough to be noteworthy, but not smart enough to avoid doing really stupid things, putting Wolfgang Amadeus Mozart's fondness for a "poop joke" alongside Karl Marx's liking for a big night out.

She also relishes the silly footnote, writing that rabbits are a successful species because they are "really good at one very important thing: hiding", adding quickly, "OK, two things". She has a keen eye for detail, such as the fact that those who want to view Marie Curie's personal possessions must "wear protective clothing and sign a liability waiver".

The format weakens with figures such as writer Maya Angelou or philosopher Émilie du Châtelet. With little evidence of stupidity, Spalding is reduced to colourful anecdotes. It sags further as the detail and context available for modern figures makes it harder to poke fun, and crumbles when she chooses NASA as her 30th genius in order to joke about astronauts peeing their pants and engineers confusing imperial and metric units.

Spalding has a good sense of perspective, pointing out that Newton's eye studies made a lot more sense with science in its infancy, and that Thomas Edison's "spirit phone" didn't sound so wild in an era when people had been bombarded with new inventions.

Among the gags, she puts the conventional notion of genius to the test. Are Leonardo da Vinci's secret notebooks a testament to his intelligence or short-sightedness? Does meteorologist James Glaisher's ballooning career show that revolutionary scientists sometimes need to be really bad at learning from their mistakes?

Spalding may not be completely serious when she declares that her subjects are "a bunch of idiots" like the rest of us, who happen to be "good enough at some hyper-specific talent" to get lucky. I couldn't say – I'm no genius.

Richard Lea is a writer and editor based in London

Benjamin Franklin knocked himself unconscious electrocuting turkeys in front of dinner guests



PICTURES FROM HISTORY/GETTY IMAGES

New Scientist recommends



Emily Wilson
Editor-in-chief
London

This week, I've been on a reading spree, ripping through four great books of varying vintages.

First up was **Romantic Comedy** by Curtis Sittenfeld (who wrote *Rodham*, a brilliant alternative history of Hillary Clinton). It's, well, a romantic comedy, but it morphs into a pandemic novel – my first, I realise.



Evie Wyld's **All the Birds, Singing** was next: a powerful story about a mysterious young woman on a sheep farm, with fantastical elements, and an interesting way with timelines. Nail-biting.

My third was **The Bookshop** by Penelope Fitzgerald, who died in 2000. You can see why this short, elegant story about a woman who sets up a bookshop in a small town was nominated for the Booker prize.

I also reread probably my favourite sci-fi book, ***A World Out of Time*** by Larry Niven. For a short book, it packs in so much.

No plays or films this week, but I am watching ***The Mandalorian*** with my youngest son. This is the way – which you won't get unless you watch *The Mandalorian*!

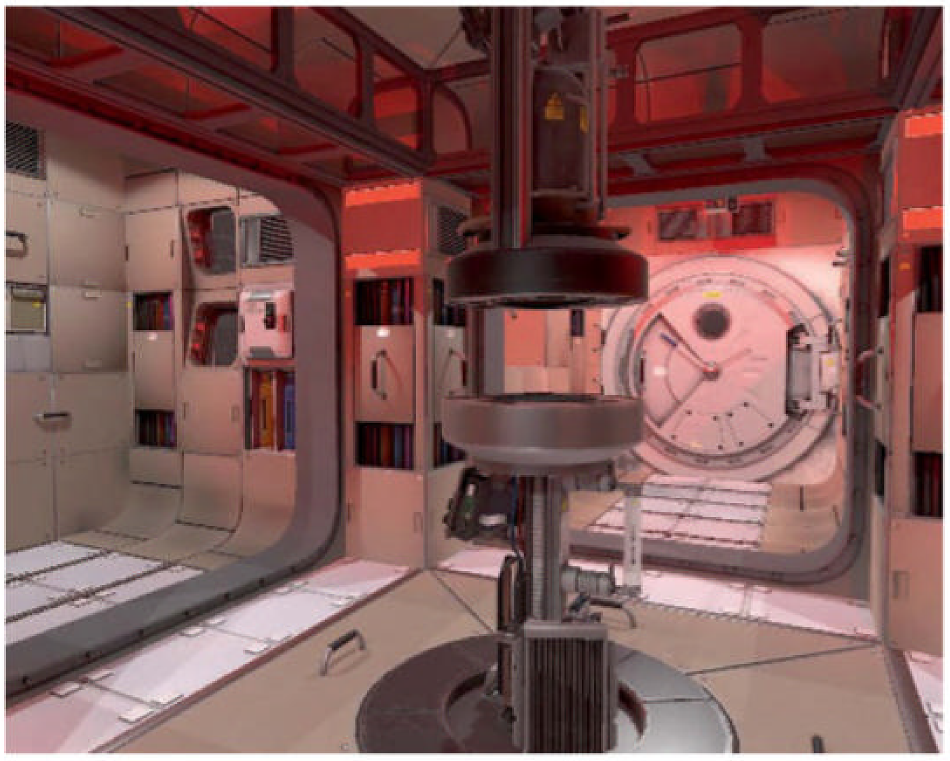
The games column

Depth not breadth

In *Tin Can*, you have to fix a spaceship's disintegrating escape pod – or die. Though the whole game takes place in a single space, exploring its extraordinary detail is a real joy, says **Jacob Aron**



Jacob Aron is *New Scientist*'s news editor. Follow him on Twitter @jjaron



TIN CAN STUDIO

In the escape pod, you have to fix the failing engineering systems

VIDEO games keep getting bigger and bigger. I don't mean the size of the industry – though with global revenues of more than $190 billion, it beats the film and music industries combined. No, it is the scope of new games. It feels as if each title in a series aims to outdo the last, to the point where players can spend hundreds of hours lost in a vast virtual world.

My record is probably 150 hours in the epic fantasy game *Skyrim*, though I am at pains to point out that was over a period of a couple of years, given it adds up to almost a full week of gaming. I do have a life outside games, I promise.

Anyway, it is understandable that developers and publishers keep feeling the need to best themselves in an effort to come up with a new marketing bullet point, but this desire for breadth overlooks the joy to be had in depth. Rather than creating a surface-level simulation of an entire world, what happens if you try to model a single space in exquisite detail?

That is the approach taken in *Tin Can*, a game that puts you in charge of a spaceship's rapidly disintegrating escape pod. You can crack open the pod's many engineering systems – everything from the lights and oxygen supply to a small nuclear reactor – and tinker with the components, swapping them around and cannibalising parts in a desperate attempt to stay alive.

"Trying to identify the problem against a ticking clock really makes you feel like you are in the escape pod"

The pod is so complex that it comes with its own manual, which you can either read on an in-game clipboard or, in a nice touch, as a PDF downloaded to your real-world phone. And you will need to – the ship's onboard computer will only tell you about problems by spitting out obscure error codes, leaving you to look them up in the manual as you try to figure out a solution. Imagine trying to set up a printer, but with added virtual mortal peril.

OK, that description might not be everyone's cup of tea, but I had a brilliant time with *Tin Can*. The feeling of picking through spare parts, trying to identify the problem against a ticking clock – and you can set how long a mission lasts before you are rescued – really makes you feel like you are hard at work in that escape pod.

When replaying the game, some elements change randomly, such as which spare parts you have on board, or which systems fail – which adds to the feeling of always being on your toes.

There is also a certain element of making your own fun in the space provided, by pushing buttons just to see what happens. This could be as mundane as disconnecting all the pod's lights and sitting in the dark, or opening the outer door and watching all your oxygen explosively decompress as you realise, yes, there is a reason not to do that.

The only negative thing I can say about the game is that I don't like the start of each run, where you have 30 seconds to scramble around some storerooms and load up your pod with parts before it ejects. I can see that the idea is to try to make you feel more in control each time, but, honestly, it is a little bit tiresome and feels like a roadblock to starting the game proper.

That is a very minor complaint, however. With developer Tin Can Studio consisting of just a few people, it is clear it has thought deeply about how to achieve a lot with very little. Sure, the voice acting is amateurish, but it is hard to care when you are tinkering with a fantastic toy. ■

Game
Tin Can
Tin Can Studio
PC, PlayStation 4 and 5, Xbox One and Series X/S, Nintendo Switch

Jacob also recommends...

Game
FTL: Faster Than Light
Subset Games
PC, iOS

The simple 2D graphics of this spaceship simulator hide hidden depths, as you have to manage oxygen, power and more to survive. My favourite thing to do is open the ship's airlocks to extinguish fires – just make sure the crew are safe first!

GALAXY
ON GLASS

SPECTACULAR WALL ART FROM
ASTROPHOTOGRAPHER CHRIS BAKER



SPECIAL OFFER!

10% Discount on all images for New Scientist readers.
Use the code NEWSCIENTIST at checkout.

www.galaxyonglass.com
chris@galaxyonglass.com | +44 (0)7814 181647

Mental muscle

We are finally getting to grips with how exercise boosts your brain and how we can all work out smarter to reap the benefits, say **Catherine de Lange**

IN JANUARY, I set myself a resolution: to master the humble chin-up. I have never had much upper body strength, and I knew it would be hard, but that is OK, I thought, because I am not doing this to get stronger or fitter. I am doing this for my brain.

Like a lot of people, I used to exercise to stay physically fit. But a few years ago, while writing my book *Brain Power: Everything you need to know for a healthy, happy brain*, I dug into the literature on exercise and the mind. What I discovered changed my relationship with exercise forever.

It is no secret that exercise is good for the brain as well as the body. But the past decade has seen an explosion of research into just how transformational it can be, whether it is improving children's academic performance, boosting mood and memory in adults or even protecting us from cognitive decline. "It seems to be one of the most important things you can do for the brain," says David Lubans at the University of Newcastle, Australia. "I think much less about the physical benefits. It's all about feeling good and optimising my brain functioning."

Scientists like Lubans are now turning their attention to how and why exercise has such powerful effects on the mind. What they are finding is teasing apart what really works and showing us how we can best capitalise on the brain-boosting powers of physical exertion.

One of the first pieces of evidence that linked exercise and the brain came in the 1990s, when geneticist Fred Gage found that exercise could lead to the growth of new brain cells in mice. Since then, studies have shown that exercise produces chemicals that make it easier for new brain cells to communicate and that it is one of the few things that can stimulate new brain cell growth in humans too, particularly in areas of the cortex vital for learning, memory and mood.

Mood is a good place to start if you want to see how exercise can impact the brain. As any regular exerciser can attest, moving the body provides an instant tonic for the mind. Even a single session can leave people feeling more positive for several hours, and more energetic.

Medicine for the mind

When it comes to mental health conditions, things are less straightforward. There is strong evidence that exercise is an effective treatment for mild and moderate depression, especially in adolescents. But in adults, results are mixed. There are also questions about how much exercise is needed to experience the benefits. Is exercise even a universal medicine? Or is it more like a medicine cabinet, with different people needing a specific type and dose?

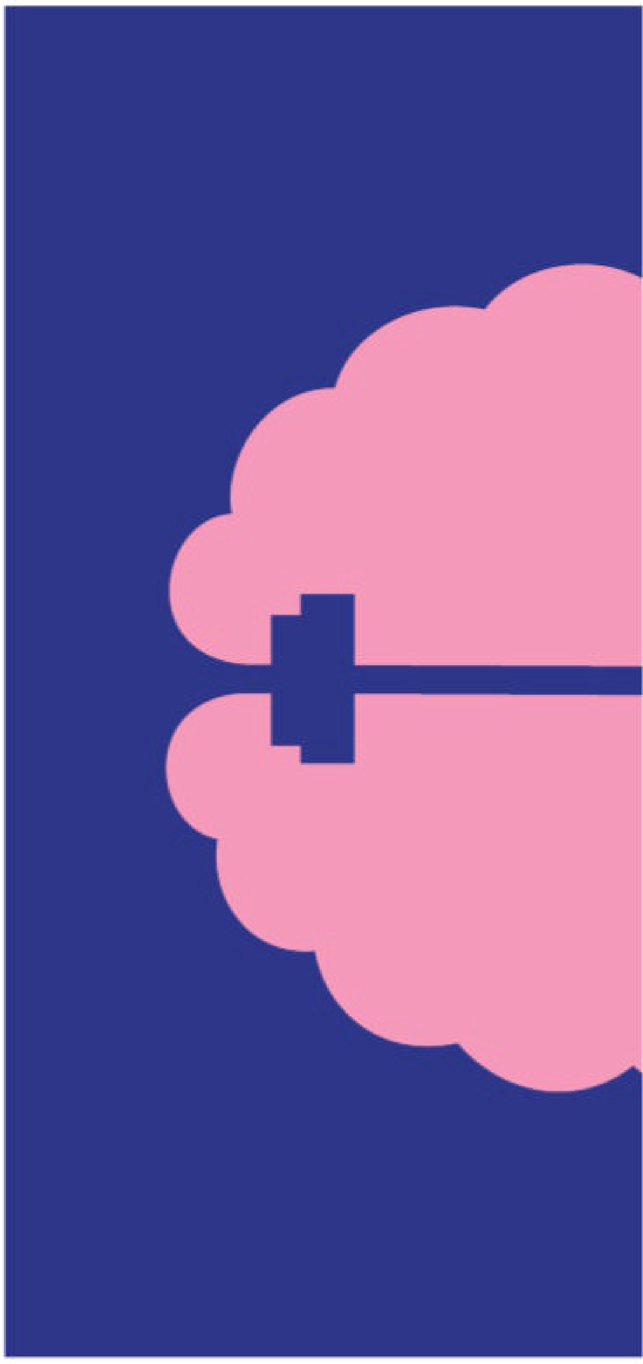
To find out more, Sammi Chekroud at the University of Oxford and his colleagues analysed information from 1.2 million people in the US, collected over several years by the US Centers for Disease Control and Prevention (CDC). The results were staggering. Compared with people who didn't exercise, those who did had experienced 43 per cent fewer days of poor mental health in the past month, and the effect was larger in people with a previous diagnosis of depression. This held true no matter the person's age, gender, race or income.

This chimes with a report published by the American College of Sports Medicine in Indiana, which found that the more exercise people did, the less likely they were to experience depression later in life. For people who did 30 minutes of physical activity every day, the odds of experiencing depression was slashed almost by half. On the flip side, sedentary behaviour seems to raise the risk.

For people who have a current diagnosis of depression, there is also good news. Earlier this year, a meta-analysis study pooling the results from over 41 studies involving more than 2000 adults found that resistance exercise (such as lifting weights) or moderate intensity aerobic exercise, performed with supervision or in a group, was an effective treatment for people with a diagnosis of major depressive disorder or those with symptoms of depression.

Chekroud's study found that all types of activity were associated with a reduction in poor mental health days. The strongest link was for team sports, followed by cycling, aerobic exercise and gym workouts. But lighter activity like walking or doing household chores counted, reducing the number of poor mental health days by almost 17.7 and 10 per cent, respectively. The benefits were comparable, and often bigger, than other predictors of good mental health, such as a higher level ›


NOMA BAR



NOMA BAR

of education or higher household income.

Strength training, such as lifting weights or doing push-ups, has also been found to reduce anxiety in adults, help ease symptoms of depression and boost self-esteem – one of the main reasons I chose a chin-up challenge as my New Year goal.

Chekroud's study wasn't perfect: it looked at a population at a particular point in time, rather than a trial or intervention. That means we can't definitively say that exercise caused the effects. Still, the evidence is building that exercise could be an effective way to boost our mood, which is why I now plan workouts into my week as non-negotiable meetings.

It needn't be a long session. Chekroud's team found that more exercise didn't always equate to more of a mood boost. For most kinds of exercise, 30 to 60 minutes per day was the ideal, associated with the lowest mental health burden. The benefits of jogging and cycling, for instance, peaked at 45 minutes.

If you need any more persuasion to plan a lunchtime workout, it also improves your cognitive skills. "I encourage people to exercise earlier in the day, because the afternoon will be more productive. I'm surprised that isn't happening more," says Lubans.

When it comes to untangling the links between exercise and cognition, most research has focused on childhood and older age as these are the times when the biggest changes in the brain take place – and so also the times when the influence of environmental factors are especially strong.

In childhood, our brains undergo rapid development, building connections that allow us to master new skills. During this window, the brain is particularly sensitive to the impact of movement. Inactivity is associated with worse academic performance in children as well as lower scores on standard cognitive tests. A small amount of exercise can make a big difference. In 2009, Charles Hillman at Northeastern University in Boston and his colleagues were the first to show that if schoolchildren aged around 9 did a single bout of moderate exercise – walking for just 20 minutes on a treadmill – they saw an almost instant improvement in brain function, cognition and academic performance, scoring better in tests of maths and reading compared with when they sat still. Other research has found that when children aged 8 to 10 took a 15 to 20-minute walk or run before school, they showed better "on-task" behaviours, such as listening or following rules, compared with days when they didn't walk or run.

Hillman is now looking into the mechanism behind these effects, with the hope of being able to influence policy on the way exercise is incorporated into schools.

The teenage years also seem to be a crucial window for the effects of exercise on the brain. Studies looking at male Swedish teenagers who were conscripted to the army aged 18, and followed up for decades, have found that low fitness at age 18 was associated with an increased risk of serious depression in adulthood, as well as early onset dementia.

Likewise, Lubans's team found that 8 to 20-minute exercise breaks, three times a week for six months, not only improved teenagers' fitness, but improved their focus in class. In those with poor mental health, it also reduced perceived stress and lowered feelings of sadness and anxiety.

The cognitive effects of exercise aren't reserved for children and teenagers. Research has revealed that keeping active can improve all sorts of thinking skills in adults too, including memory, concentration and creativity, supporting the idea that taking a break from work to exercise could make us all more productive.

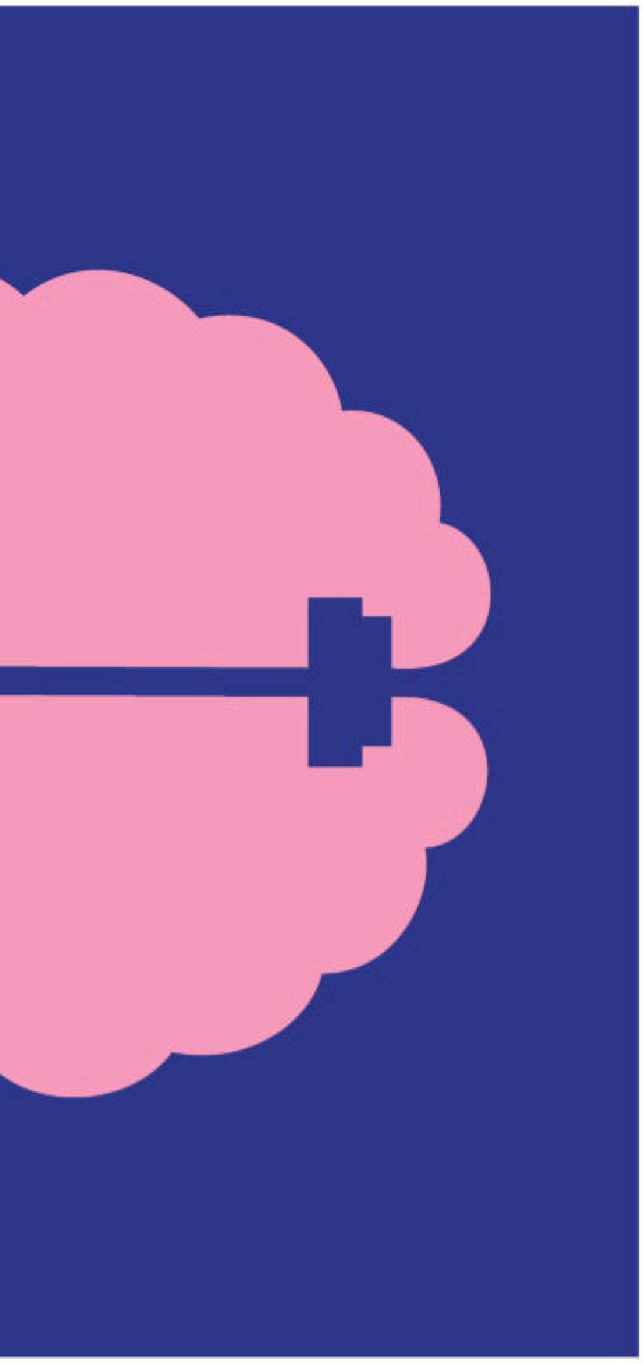


GEBER86/GETTY IMAGES

Exercising improves children's behaviour in class

It could also be one of the best investments for our future. "We've seen that exercise could be potentially one of the biggest factors to prevent Alzheimer's disease and other types of dementia," says Eef Hogervorst, who studies exercise and cognition at Loughborough University in the UK. And unlike a healthy diet and giving up smoking, which have the biggest impact on the brain if done before you develop dementia symptoms, says Hogervorst, exercise is beneficial until you die.

Compelling evidence that exercise keeps brains youthful comes from a meta-analysis that pooled 15 studies totalling over 30,000 participants, who were followed for up to 12 years. It found that people who exercised – even at low intensity – had an almost 40 per



cent lower risk of cognitive decline. Another analysis that included 45 studies that followed 100,000 people for as long as 28 years found that when people did regular moderate or high-intensity exercise, it reduced the risk of developing cognitive problems by 18 per cent.

Hogervorst points out that exercise is one of the few things you can do to not only help prevent dementia, but also to slow down decline if you are already experiencing symptoms. In people with and without dementia, memory improves just 24 hours after a single resistance band session, and the results are even better after several weeks, says Hogervorst.

The evidence isn't unanimous, however, and in recent months some large reviews of studies have questioned whether such results have been overhyped. There may be many reasons for inconsistent results, says evolutionary biologist David Raichlen at the University of Arizona. The age of participants, the types of exercise performed and the parts of the brain that are targeted will all have an impact. "What the inconsistency really tells us is that there is much more work to do," he says.

Your ravenous brain

Conflicting results make it even more important to understand the mechanisms underlying any effects, and this is where things have really taken off lately. One of the most familiar explanations is that "what is good for the body is good for the brain". The brain is ravenous, burning through a huge amount of energy and requiring a constant supply of oxygen and nutrients to be delivered through the circulatory system. Exercise helps keep this network of blood vessels healthy and blood pressure low. This is important because studies have shown that high blood pressure is linked to a reduction in cognitive performance and is a risk factor for dementia. Exercise also reduces the risk of diabetes and obesity, both strong risk factors for neurodegeneration later in life.

Exercise does more than just pump more blood to the brain, however. It is easy to think of your muscles as passive workhorses that respond to signals from the brain when we need to walk, run or attempt a chin-up. But skeletal muscles – those attached to our bones that we activate when we exercise – are far from passive. They are constantly communicating with the rest of the body, including the brain. When we exercise, our muscles pump out a potent cocktail of hormones and other proteins, many of which can travel to the brain. Called myokines, these are thought to be so influential on our mood and behaviour that they have been nicknamed the "hope chemicals".

Myokines have also been implicated in the growth of new brain cells. Historically, it was thought that we were born with all the brain cells we will ever have, but we have since discovered that exercise is one of the few things that can spur new brain cell growth.

The most well-studied hope chemical, brain-derived neurotrophic factor (BDNF), has been linked to the growth of new brain cells in the hippocampus of humans, and improvements in learning and memory. A flurry of new cells in the hippocampus could be one explanation for the cognitive boost experienced after exercise. A lack of new cell growth in the brain has also been implicated in dementia and mental health conditions, so encouraging this growth could explain the improvements we see in people affected by these, too.

The more we understand about these ›

"Strength training such as push-ups reduces anxiety and boosts self-esteem"

HACK YOUR EXERCISE FOR THE BEST BRAIN BOOST

1. Pick activities that keep you on your toes and challenge your brain. Think sports like hockey, badminton and football. They lead to a bigger boost of brain-derived neurotrophic factor, or BDNF, a protein that promotes new brain cell growth and its associated cognitive benefits.

2. If you are studying, try learning on the go. In a study of people memorising new Polish vocabulary, participants remembered more new words if they walked while they studied.

3. Struggling to give up smoking? A mere 15 minutes of moderate exercise reduces cigarette cravings – and dampens down activity in brain areas that drive the urge.

4. Exercise that happens as a result of work isn't as effective as that done by choice, so try to make time for it in your diary, and have fun.

5. Don't make excuses: even a single bout of exercise is enough to boost executive functions, thinking speed, attention and memory.

New Scientist audio
You can now listen to many articles – look for the headphones icon in our app **newscientist.com/app**

chemicals, the more we can try to home in on which kinds of exercise produce them and therefore are the most beneficial, and in what dose. Some answers are starting to emerge. One paper looked at studies of three types of exercise: aerobic exercise, intense anaerobic exercise such as HIIT training, and strength training (hello chin-ups!). For a start, it found that HIIT training seemed to offer more cognitive improvements than lower intensity aerobic exercise. Strikingly, strength training seemed to result in a greater variety of myokines being released from muscles. One of these, insulin growth factor 1, enhances the growth and survival of neurons, and has been linked with cognitive performance. Another, irisin, is often reduced in people with Alzheimer's disease.



ISLANDSTOCK/ALAMY

Group exercise can combat feelings of loneliness and isolation and protect against various mental health conditions

Runner's high

All of this could help explain why older women with mild cognitive impairment who were at risk of developing Alzheimer's and did resistance training twice a week for six months scored better on tests of attention and memory than those who did aerobic exercise or stretching.

High grip strength, which is a good proxy for overall muscle strength, is associated with better memory and reaction times as well as spatial and verbal cognitive skills in people over 65, and is linked to higher attention and reasoning skills. In fact, the effects of muscle on the mind are so strong that it can even be used as a predictor of cognitive decline: if you lose your grip strength, your cognitive power will probably follow suit. So while aerobic exercise that gets the blood – and all of those vital chemicals – pumping round the body is a good bet, resistance training seems like it could give the most bang for its buck.

Exercise can also help brain cells communicate more efficiently by directly boosting neurotransmitters, such as GABA and glutamate. While this seems to improve memory, it could also play a role in mood, since low levels of these chemicals are implicated in depression. It has also been shown to boost other neurotransmitters, such as dopamine – leading to the feeling of euphoria or "runner's high".

All of these are short-term shifts in brain activity, but both Hillman and Lubans have found evidence that exercise can cause long-term structural and functional changes to the brain, too. Lubans has shown how exercise boosts metabolism in the hippocampus, helping it deliver the ingredients for structural change, and Hillman has demonstrated that exercise helps improve white matter integrity, which helps different parts of the brain speak to one another, allowing people to process information quicker and do better mental gymnastics like multitasking and planning.

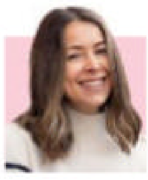
"The best exercise is one that makes you move and think at the same time"

When it comes to choosing the best exercise for you, you might want to consider who you do it with. Chekroud and his colleagues found team sports to be the most beneficial for mental health, which makes sense given that social activity promotes resilience to stress and reduces risk of depression. The social side of team sports could also help to reduce the social withdrawal and feelings of isolation that often go hand in hand with depression and other mental health issues.

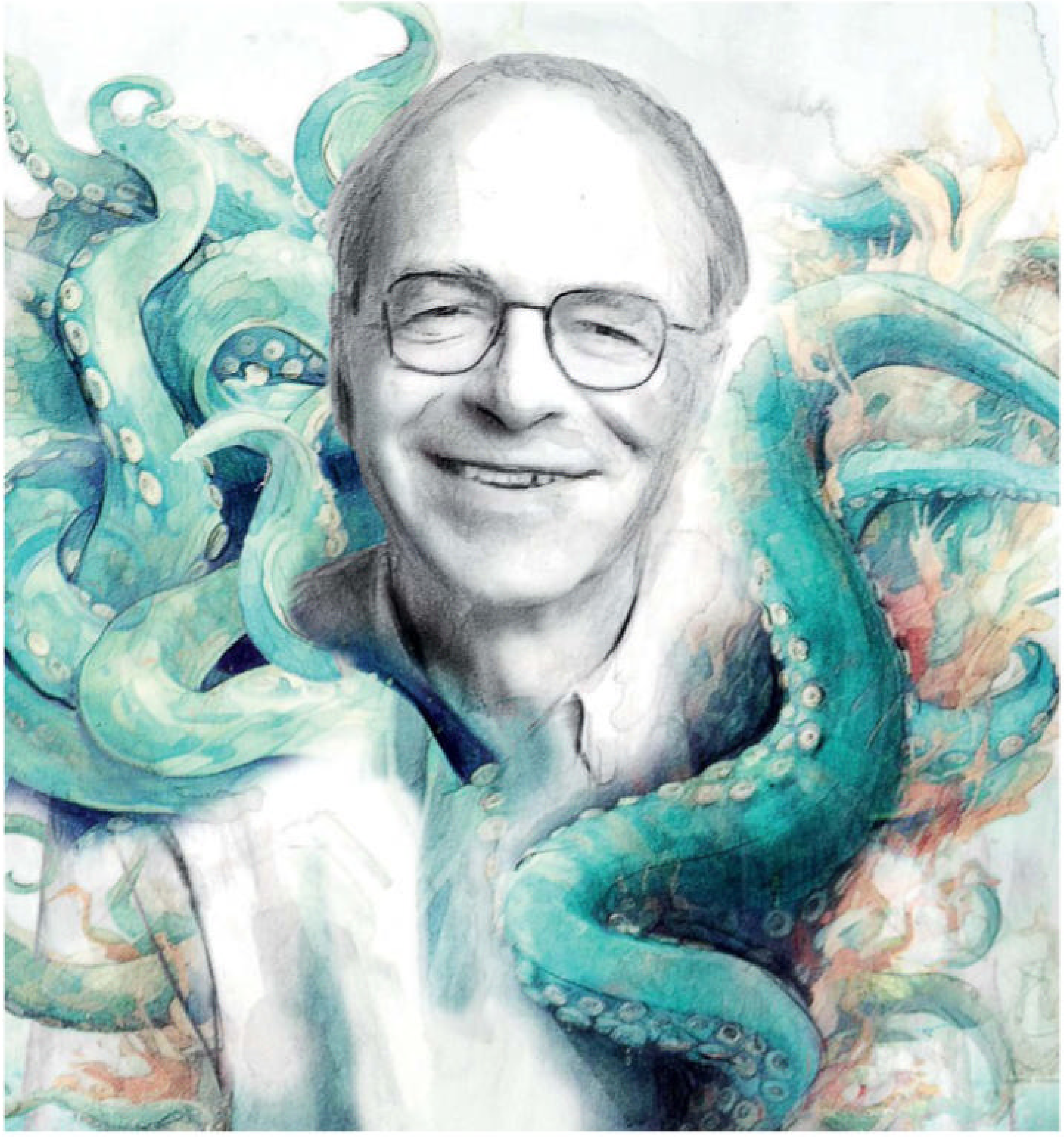
There is also a school of thought that says the best exercise is one that is cognitively stimulating or, to put it another way, one that makes you move and think at the same time, such as rock climbing, team sports or martial arts. This may have roots in the way our ancestors evolved to be active. When they began walking on two legs and hunting their food over long distances, the simultaneous demands of navigating, communicating and scanning the environment while on the move would have put a huge new cognitive burden on our species. Some researchers believe that this could have been what drove the development of our larger, smarter brains.

This suggests that we may need to challenge our brains to see the biggest benefits, and it may be one explanation for why we sometimes find inconsistent results between individuals and different studies, says Raichlen. Indeed, Tracy Alloway at the University of North Florida and her colleagues found that adults who engaged in cognitively demanding exercises performed better later on in tests of memory compared with those who took yoga classes.

Finally, whatever you choose, make sure it is something you enjoy. Unsurprisingly, studies show that people who are made to do tough levels of exercise in lab experiments experience a dip in their mood. I have come to love my own fitness challenge. My chin-up is still elusive, but it is inching closer. In the meantime, my mental muscle is in better shape than ever. ▮



Catherine de Lange is magazine editor at *New Scientist*. This article is adapted from her book *Brain Power* (shop.newscientist.com)



NABIL NEZZAR

"We can't go on with business as usual and think we are ethical"

Controversial bioethicist **Peter Singer** has a new perspective on killing humanely raised animals for food. But climate ethics keeps them off the menu, he tells Madeleine Cuff

PETER SINGER's book *Animal Liberation* was a "philosophical bombshell" when it came out in 1975, according to activist Ingrid Newkirk, who says it "made people — myself included – change what we ate, what we wore and how we perceived animals".

Singer, now a professor of bioethics at Princeton University, provided a philosophical argument for overhauling humanity's treatment of animals, condemning practices such as animal testing and meat eating on the grounds that animals had as much right to live free from pain and suffering as humans.

Although it helped inspire the modern animal-rights movement, Singer's views on animal ethics were, for a long time, far from mainstream. For decades, vegetarians and vegans were treated by many other people with equal parts bemusement and exasperation. Factory farms flourished.

Now, we have a deeper understanding of the intelligence of many animals, from pigs to octopuses, as well as evidence to show that veganism – which is more popular than ever – is good for our health and the environment. And yet global meat and fish consumption is still rising, plans are afoot for the world's first octopus farm and escalating climate change is driving many animals to extinction. Against this backdrop, Singer has revised *Animal Liberation* for a 21st-century audience.

He tells *New Scientist* how his thinking on animal rights has changed, why beef should be taxed to help the people affected by climate change and what an ethical life looks like now.

"Eating humanely raised animals is a philosophical problem that has yet to be solved"

Madeleine Cuff: For those who aren't familiar with your arguments, where do you stand on humanity's treatment of animals?

Peter Singer: I think the core arguments I made in 1975 have stood up very well to the test of time. I argued that we should give equal weight to similar amounts of pain and pleasure, irrespective of species. It's just as bad if pain is inflicted on a human or a dog or a pig.

Why did you feel the need to update your book?

I did a reasonably thorough revision in 1990, but I hadn't touched the body of the text since then. If you looked at the chapter on factory farming, it was describing conditions in the 1980s or earlier. The same was true about the chapter on the use of animals in research. I thought that people reading this book would no longer feel it is relevant. They would want to know, are we still doing these things to animals? Has it got better? Has it got worse? Also, climate change is obviously a big issue now and it is relevant to what we ought to eat. There wasn't much discussion of that even in the 1990 edition.

How has your thinking around the eating of animals evolved since 1975?

I've become a little more open to the idea that if we rear animals in ways that give them good lives and take care to make sure that they do not suffer when they are killed, then that's a defensible ethical position.

In the first edition, I rejected that. But I have thought about the whole issue more since then. It relates to some difficult philosophical questions about bringing new beings into existence and giving them good lives. Is that a plus? Or once they come into existence, maybe you can't justify ending their lives, even if it's the case that if you didn't there would be no more beings after that, because a farmer is not going to rear animals and wait for them to die a natural death before trying to sell their bodies.

It's still not my view, but I now see some of the difficulties in rejecting it. I regard it as a kind of unsolved philosophical problem.

So, it may be that not all killing of animals for food is wrong?

Exactly. That's possible. I'm not saying that I accept that, but I'm saying that it's a defensible position. I think people who are conscientious about ensuring that any meat they buy comes from animals who have had good lives – they hold a position that I'm not prepared to say flatly is immoral or wrong.

How much should climate change be a factor in people's diets? Eating ethically to maximise animal welfare and eating ethically to minimise climate change aren't always the same thing.

That's absolutely correct. They are in conflict. If you were to follow what I was just saying about animals who have good lives, then you might say that the best meat to eat is beef because it's possible to get beef from animals who have lived all of their lives on grass. Generally, I would say that quality of life is OK.

But the greenhouse gas emissions are very high from ruminant animals because they produce methane, an extremely potent greenhouse gas. By comparison, chickens



MIKE KIPLING PHOTOGRAPHY/ALAMY

Cows contribute a hefty amount to greenhouse gas emissions

don't produce methane and so there's much less of a climate change implication in eating chicken. But most chicken is factory-farmed.

So, if people simply switch from beef to chicken for climate reasons – OK, they are reducing their greenhouse gas footprint, but they're causing a lot more suffering to animals. I think it's better to avoid both and to follow a plant-based diet. Then you don't have to worry about inflicting harm on animals and your greenhouse gas footprint will be much lower.

Proposals for an octopus farm in the Canary Islands, Spain, where octopuses would be bred for food, were recently revealed. We are learning a lot about the intelligence of these animals. What are your thoughts on this?
I am totally appalled by the plans and the idea of 1 million of these intelligent, sentient beings being closely confined and then killed. I hope it can be stopped.

Can you rely on people to make changes to their diet on ethical grounds solely or do governments need to get involved?
I think it would be perfectly reasonable for governments to impose taxes on beef, lamb and dairy – the products that are doing most damage to the climate. Because, really, any economist would acknowledge that it's a failure of the market that the price people pay for those products does not include the harm done to third parties. It's what economists call negative externalities. And it's doing harm to a lot of people – particularly to some of the poorest people in the world, who have the lowest greenhouse gas footprints, but also the least ability to overcome the problems of climate change. That's just wrong, and governments should recognise it's wrong. They should add to the price of these products so that people buy less of them. The tax revenue should be used to help people in those countries in need of assistance.

Do you see a future in which eating meat and dairy will become morally unacceptable?
The long-term development of ethics and morality will expand the circle of moral concern. I think that will, in the long run, lead to the inclusion of non-human animals in an ethical framework that means that we cannot treat them as we are now treating them. But it's very hard to put a time frame on it. It's a really big change. It might be 50 years, but it might be over a century. If we get products that taste and chew like meat and have the nutritional qualities of meat, but don't come from animals, then we may get there a lot faster.



ALEX CAVENDISH/NURPHOTO VIA GETTY IMAGES

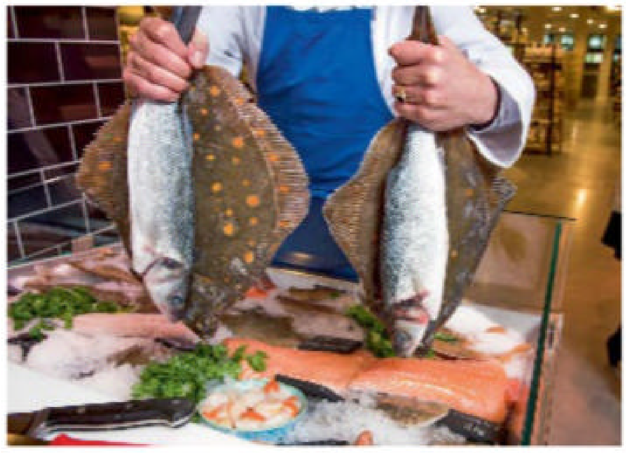
Peter Singer's view that all species have the right to live free of pain helped inspire the modern animal rights movement

There's a lot of talk about artificial intelligence at the moment. Can AI help us live a more ethical life?
I see AI as relieving us of a lot of mundane tasks. But it's only going to be a good thing if the benefits are really distributed to everyone. If it just means that some people become unemployed and wealthy people become even wealthier, it's clearly not a good thing.

It's also important that AI should not have the kind of species biases that we have. The problem is, in part, that AI is being trained on existing literature. AI like ChatGPT is reading and absorbing attitudes from billions of pages of text and often that leads to perpetuation of particular views that people have now.

Most of the AIs, if you say: 'Can you give me some recipes for cooking pork?', they will do it immediately. But if you say: 'Can you give me some recipes for cooking dogs?', most of them will say: 'No, it's wrong to cook dogs.' Why is it wrong to cook dogs and not wrong to cook pigs?

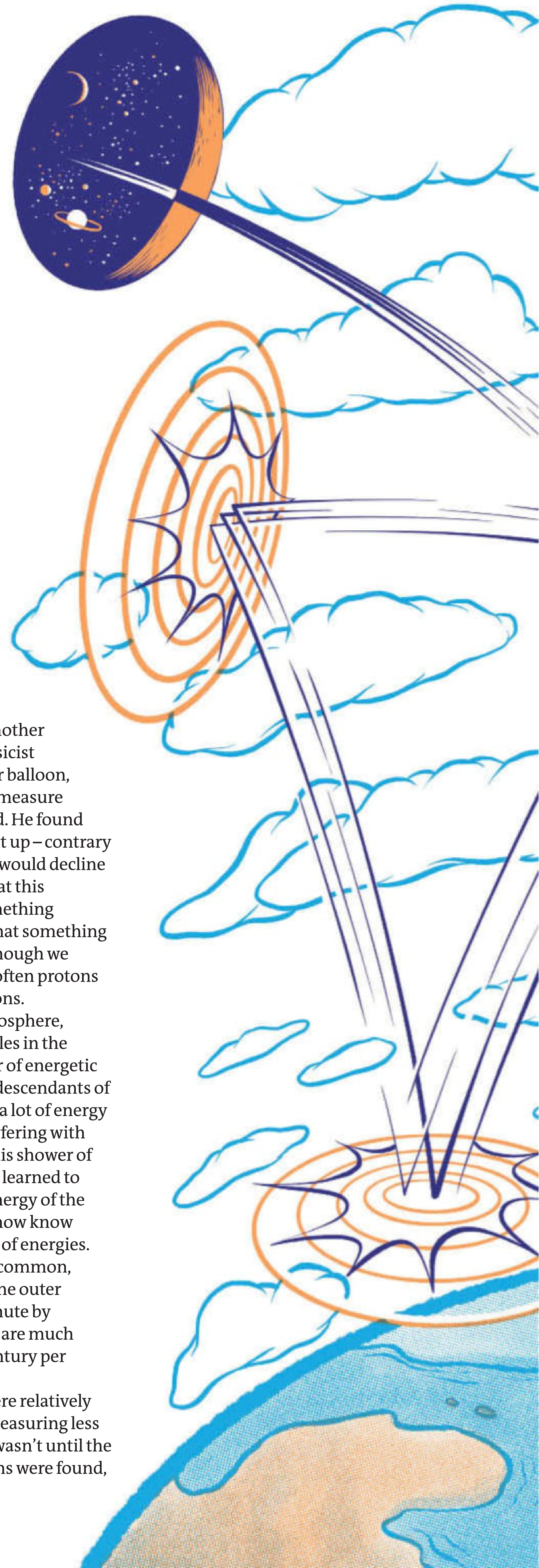
There is a concern that AI is perpetuating the biases that we humans have. A lot of work is going into correcting racist and sexist biases in AI and that's good, but it should also go into correcting species biases.


ADRIAN SHERRATT/ALAMY

And finally, what does it mean to live an ethical life in the context of climate change?
We need to consider what we can do to reduce the damage that climate change is doing and will do in future. Our children and grandchildren are going to ask us, what did we do to stop the problems they are going to have to live with? I think we want to be able to give them an honest and serious answer that we did a great deal, that we did everything we could to prevent this damage. We can't just go on with business as usual and think that we are an ethical person. ∎

Peter Singer's book Animal Liberation Now *is out on 8 June.*


Madeleine Cuff is an environment reporter at *New Scientist*



The Oh-My-God particle

Thirty years ago, we spotted a particle from space with the energy of a dropped bowling ball. Where did this monster and the ones that followed it come from? **Jonathan O'Callaghan** joins the hunt

THE helicopter was flying high through the night sky with its door slightly ajar. Johannes Eser and Matthew Rodencal were in the back controlling a laser pointing out through the gap. They aimed towards a balloon 35 kilometres above them and fired.

It sounds like a scene from a spy movie, but Eser and Rodencal, then at the Colorado School of Mines, were actually testing a plan to spot ultra-high-energy cosmic rays, the most energetic particles ever discovered. They stream across the universe before slamming into our atmosphere and emitting a tiny flash of light. The laser was supposed to mimic that flash.

This twilight helicopter ride happened nearly a decade ago, but is part of a saga that goes back to at least 1991. In October that year, we detected the single most energetic particle ever seen. It had the kinetic energy of a bowling ball dropped from shoulder height, crammed into a subatomic-sized package. It quickly became known as the "Oh-My-God particle" and, naturally enough, scientists were desperate to know where it came from.

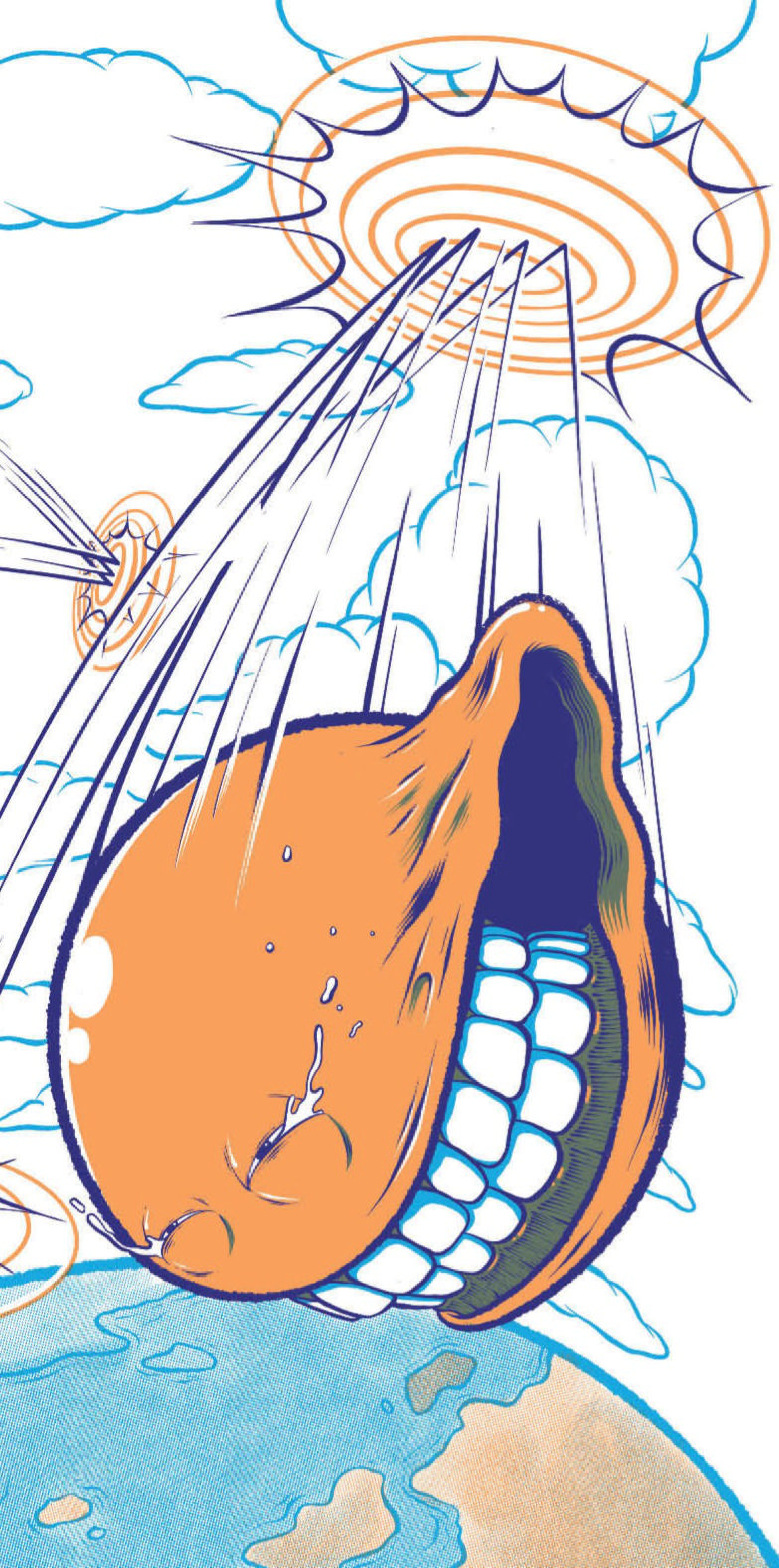
Since then, we have spotted many similar particles. Huge ground-based detectors have provided us with maps of where they might come from, together with a shortlist of the extreme cosmic objects that could produce them. But truth be told, we still don't have all the answers. That is why scientists now want to take the cosmic ray hunt into the atmosphere – and ultimately into space – in an effort to solve the mystery once and for all.

This story really began with another balloon in 1911. At that time, physicist Victor Hess climbed into a hot air balloon, taking with him instruments to measure levels of radiation as he ascended. He found the readings increased as he went up – contrary to the prevailing belief that they would decline with altitude – and concluded that this radiation must be caused by something coming from space, not Earth. That something became known as cosmic rays, though we now know them to be particles, often protons or clusters of protons and neutrons.

When cosmic rays hit our atmosphere, they usually collide with molecules in the atmosphere, producing a shower of energetic particles that rain down. (These descendants of the original particle still contain a lot of energy and have been suspected of interfering with the electronics of aircraft.) It is this shower of secondary particles that we have learned to detect, allowing us to infer the energy of the cosmic ray that produced it. We now know that cosmic rays come in a range of energies. The least energetic are the most common, with each square centimetre of the outer atmosphere being hit once a minute by one of them. The most energetic are much rarer – they strike only once a century per square kilometre.

The rays that Hess detected were relatively modest in energy, it turns out, measuring less than 1 gigaelectronvolt (GeV). It wasn't until the 1960s that more extreme versions were found,

RENAUD VIGOURT



when physicist John Linsley used an array of ground detectors in New Mexico to spot the shower created by a cosmic ray with the vastly greater energy of 100 exaelectronvolts (EeV).

That was a staggering find. But the best was yet to come. In the 1980s, a larger project called the Fly's Eye telescope array was built in Utah. It had more than 100 detectors, each equipped with a 1.5-metre-wide mirror to look for the flash of particles colliding in the atmosphere. Each of the telescope's detectors were designed to point at a different part of the field of view, in a similar way to insects' compound eyes. It was this that earned the telescope its name. "We were hoping we might pick up something really unusual," says David Kieda at the University of Utah, who worked on the telescope at the time.

The Fly's Eye

On the night of 15 October 1991, Fly's Eye spotted the flash of a cosmic ray with a whopping 320 EeV of energy. The researchers sat on the result for more than a year, only announcing it in 1993 once they were convinced it was real. The discovery was initially called the "WTF particle", but after going public, a new name was coined by a now-retired engineer called John Walker. That same year, a book about the then-hypothetical Higgs boson, called *The God Particle*, had been published. "Something with the energy of a brick landing on your toe seemed a lot more impressive [than the Higgs]," says Walker. "So I called it the 'Oh-My-God particle'." Walker wrote about it on his website and the name stuck.

The OMG particle remains the wildest cosmic ray ever seen. It arrived from the direction of the Perseus constellation in the northern hemisphere and hit our atmosphere at 99.99999999999999999999951 per cent of the speed of light. Its energy was millions of times higher than anything produced at the Large Hadron Collider, the world's best particle accelerator (see "Powerful particles", page 48).

Since 1991, hundreds more particles with an energy over 1 EeV have been found, and these are now known as ultra-high-energy cosmic rays (UHECRs). But what could be producing them? It must be an object of truly awesome power. "We just found this fascinating," says Angela Olinto at the University of Chicago.

Back in the 1990s, scientists thought these zinger particles could be "remnants from the early universe", says Rene Ong at the University of California, Los Angeles. The idea was that ›

more-massive particles in the early universe may perhaps have decayed into cosmic rays. Some even wondered if studying them might provide a window back to a cosmic era when the fundamental forces may have been merged. "There was a huge amount of interest because of the implications for this model," says Kieda.

But there was a problem. In 1964, astronomers had discovered cosmic microwave background radiation, the remnant heat of the big bang that pervades the universe. The following year, three scientists – Kenneth Greisen, Georgiy Zatsepin and Vadim Kuzmin – suggested this would place a limit on how far extremely energetic particles could travel. Any with an energy above 50 EeV coming from more than 300 million light years from Earth would be destroyed as they interacted with the background radiation. This became known as the GZK cutoff. "It's essentially a speed limit for the universe," says Eric Mayotte at the Colorado School of Mines.

Jumbled fields

By 2007, an upgraded version of the Fly's Eye telescope had observed dozens more UHECRs and seen that there was a pronounced drop in numbers that had energies beyond the GZK cutoff. Such rare, highly energetic particles were now sometimes referred to as Extreme-Energy Cosmic Rays (EECRs). This observation suggested that whatever was firing them at us must be relatively close in space and time.

One of the most powerful mechanisms we know of for accelerating particles is for them to ride an expanding shock wave from a cosmic explosion. The shock waves can be filled with a jumble of magnetic fields, and particles can criss-cross these fields, picking up more and more energy as they go.

These waves can be created in several ways. One involves what is known as a tidal disruption event, where a star is torn apart by a black hole, producing a powerful jet of plasma as the star's material is swept up. "They're fascinating systems," says Glennys Farrar at New York University. But they last only a short time, often a matter of months, casting some doubt on their potential to be the source of OMG particles.

A more promising candidate might be active galactic nuclei, or AGNs. These are dense and highly luminous areas at the centre of some galaxies, assumed to house a supermassive black hole. They are relatively common too. "One in every 1000 galaxies has an AGN," says Daniele Fargion at the Sapienza University of Rome in Italy. The closest to Earth, Centaurus A, is roughly 13 million light years away. Such AGNs can fire out jets of superheated plasma, and these constantly produce shock waves as they affect surrounding intergalactic space, says James Matthews at the University of Oxford. This means AGNs are a promising contender for producing OMG particles.

Other short-lived events – such as powerful explosions known as gamma ray bursts, the sources of which are unknown – have also been proposed as the source, as have starburst galaxies, where intense regions of star formation could form the conditions necessary to accelerate particles to the speed required.

To know for sure, we need a comprehensive map of where the highest-energy cosmic rays come from. Over the past decade, that map has been taking shape, thanks to two facilities. The Pierre Auger Observatory is an array of 1600 detectors in Argentina that observes incoming cosmic rays in the southern hemisphere sky. The prosaically named Telescope Array in Utah, with more than 500 detectors, does likewise in the northern hemisphere's sky.

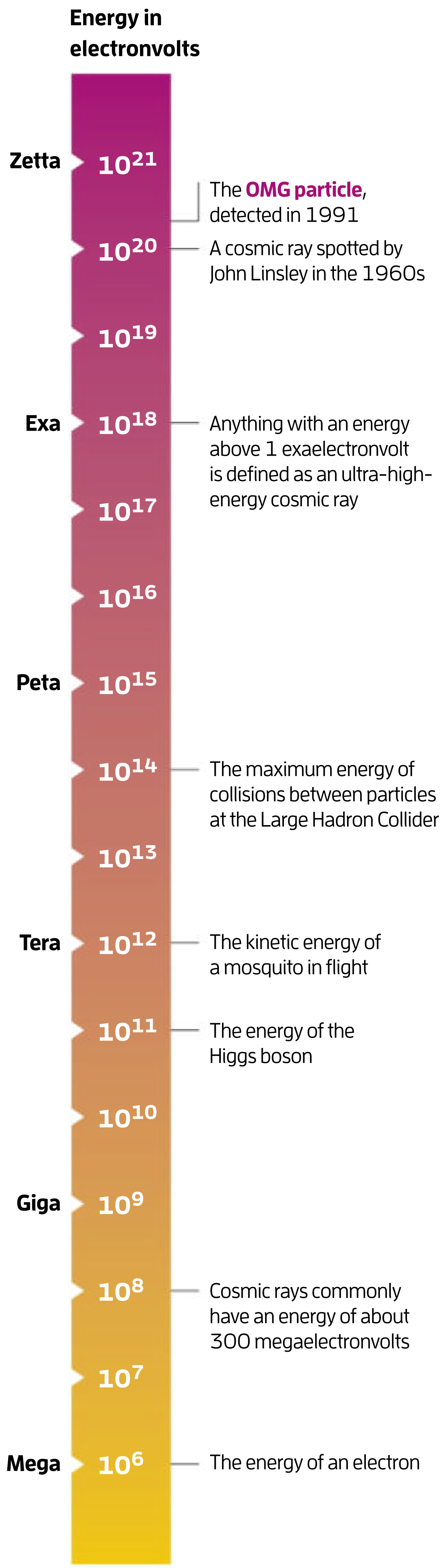
Processing their observations isn't straightforward because the trajectories of EECRs are bent by magnetic fields on their way to us, meaning their true origin needs to be reconstructed using computer models. Still, by 2017, both observatories had released their own map of where cosmic rays come from. Each of these showed an intriguing hotspot in the sky where large numbers of the particles appear to come from (see graphic, right, which shows the combined map). One centres on Centaurus A, the other on a galaxy about 53 million light years from us called M87, famous for the black hole at its centre that was imaged in 2019. Both galaxies are known to contain an AGN, which bolstered the case for those being the source of EECRs.

Case closed? Not at all. While confidence in the Centaurus A hotspot has grown since 2019, with more cosmic rays found to be coming from its direction, the opposite is true for the M87 hotspot. "If anything, the significance is falling, which is pretty worrying," says Alan Watson, who set up the Auger observatory but is now retired.

Complicating matters further is a fresh result from the Telescope Array, announced at a conference in October 2022. Scientists revealed the array had seen its most energetic cosmic ray yet. At 244 EeV, it is below the original OMG particle, but still a whopper.

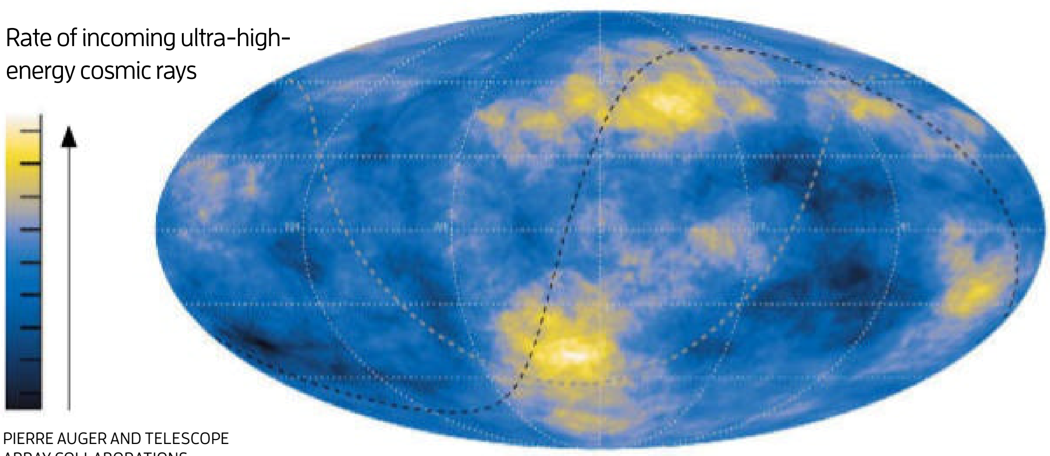
Powerful particles

Ultra-high-energy cosmic rays are packed with a truly incredible amount of energy





The Fly's Eye telescope array, Utah, pictured in 1983



This map of the sky shows two large hotspots from which a significant number of the highest-energy cosmic rays come from. Both are centred on galaxies that contain an active galactic nucleus, thought to be a likely source of these rays

"It's the highest energy we've seen," says Jihyun Kim at the University of Utah, part of the array's team. Yet its apparent origin is nowhere near any other possible sources, seemingly in an empty region of space. "We are trying to understand what happened," says Kim.

All of which takes us back to that nocturnal helicopter flight. The test was part of the preparations for an international collaboration called EUSO-SPB2. At its heart is a cosmic ray detector on a balloon lofted into the stratosphere. From this vantage point, it will be capable of spotting many more of the flashes of light from incoming cosmic rays than a ground-based detector can. The balloon launched on 13 May, but crashed unexpectedly shortly afterwards. The team hasn't yet confirmed its next steps.

However, EUSO-SPB2 is predominantly a demonstrator for an even more ambitious project: a billion-dollar space telescope that can monitor even larger regions of Earth's atmosphere for EECRs. In 2020, NASA decided to develop this idea, called the Probe of Extreme Multi-Messenger Astrophysics (POEMMA), and it could launch in the 2030s.

"By looking down from space, you can see a huge chunk of the atmosphere," says Olinto, who leads POEMMA, providing at least 10 times more detections than current Earth-based arrays. POEMMA should also be able to discern the nature of incoming particles more easily than ground-based arrays, namely whether they are protons or heavier nuclei of iron, carbon, helium and other elements. Having this knowledge allows their path back through space to be more easily reconstructed.

Chewed up and shot at

Meanwhile, arrays on Earth are still gathering observations of cosmic rays – which isn't without challenges. "Sometimes the battery is dead. Sometimes cows and horses chew our cables. Or sometimes people, just normal Utah people, shoot our detectors on the Telescope Array," says Kim. "I don't understand why. Just for fun I guess."

Scientists are also upgrading the Pierre Auger Observatory to an enhanced array called AugerPrime, which is due to be finished next year. There is also a plan to upgrade the Telescope Array to make it four times larger. Both projects should provide vital new data on the sources of UHECRs. "We are really on the cusp of getting to the core questions," says Mayotte.

There is also a left-field possibility. Maybe, just maybe, there is some exotic, as-yet-undiscovered physics that allows some EECRs particles to exceed the GZK distance limit and perhaps originate much further back in the universe's history than we have assumed. "Maybe they don't follow these rules," says Kim. That is an exciting prospect. "If we can't explain them using the forces and particles that we know, it opens up the possibility that we are exploring beyond the standard model of particle physics," says Kieda.

Matthews has another alternative. In a paper published in March, he suggested that large groups of galaxies, such as the nearby Council of Giants, could deflect cosmic rays from more plausible sources like AGNs. It could be that the picture we see of cosmic rays coming at us from all over the place is a mirage; maybe they come from one source, like Centaurus A, and get deflected in strange ways. "You get this pattern where there are blobs from echoes," says Matthews.

Discovering the origin of the highest-energy cosmic rays may have huge implications for our understanding of the universe. But there are broader implications too. These rays are dangerous because, without an atmosphere, they could reach us and skim through living tissue, leaving a wake of damaged cells and DNA. This means they could affect the habitability of some other worlds, where these high-energy bullets reach the surface. "It may be very important to know what elevated doses of ultra-high-energy cosmic radiation can do to a biosphere" before a world has developed a protective atmosphere, says Noémie Globus at the University of California, Santa Cruz. "It could destroy life or sterilise a planetary surface."

For now, the mystery pervades, yet an answer may not be far away – albeit not a simple one. "I think there's going to be lots of different kinds of OMG particles," says Farrar, perhaps some from AGNs, some from tidal disruption events and some from gamma-ray bursts. Finally figuring this out would be a fitting reward for scientists who are willing to go to quite some lengths to solve the puzzle – even firing lasers from a helicopter. ∎



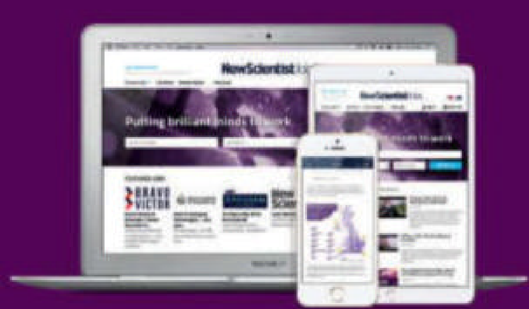
Jonathan O'Callaghan is a journalist based in the UK who covers space

New Scientist Jobs



Recruit the brightest minds in science

At New Scientist Jobs, we can help you to reach, engage and attract the highest-quality job applicants, wherever they are. Over 157,000 people* come to our site every month looking for their dream job and ideal employer – which could be you!



newscientistjobs.com

*Source: Google Analysis Jan-Dec 2021

Puzzles
Try our crossword, quick quiz and logic puzzle p53

***Almost* the last word**
Can drinking tea counteract eating a hot dog? p54

Tom Gauld for *New Scientist*
A cartoonist's take on the world p55

Feedback
Jerky jargon and a ratty theory of everything p56

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p56

Stargazing at home

The 13th sign

Ophiuchus is sometimes referred to as the 13th zodiacal constellation. Now is a great time to spot it, says **Abigail Beall**



Abigail Beall is a features editor at *New Scientist* and author of *The Art of Urban Astronomy*. @abbybeall

What you need

Binoculars or a small telescope for a closer view – although Ophiuchus is visible with the naked eye in good conditions

Stargazing at home appears every four weeks. Share your stargazing successes with us on Twitter and Instagram @newscientist, using the hashtag #NewScientistStargazing

Next week

Mathematics of life

EVERY so often, people who are into astrology discover Ophiuchus, which is often referred to as the 13th zodiacal constellation. Sometimes, they will be surprised a new sign of the zodiac has been invented, but in reality, Ophiuchus (pictured) is a constellation that has been known about ever since ancient Greek astronomers named it after a serpent bearer. This month is a great time to look for it around the world.

Ophiuchus sits alongside Sagittarius and Scorpius, near the bright centre of the Milky Way. With its position just to the side of the Milky Way's band, it is much fainter than its neighbours. The constellation is visible around the world, but viewers in the southern hemisphere will have a better chance of seeing it this month, since the nights are longer and darker there this time of year.

To find Ophiuchus in the northern hemisphere, look south-east as soon as it is dark. First, identify Antares, a reddish star in the head of Scorpius. At dusk in this region of the globe, Antares is the brightest star near the southern horizon, and it sits next to a line of three fainter stars. Then, to the left of Antares, find Sabik, the brightest star in Ophiuchus. The rest of Ophiuchus, which is shaped like a large pentagon, is directly above Sabik.

This method will work whenever you look, but on 4 June in the northern hemisphere, the almost-full moon will rise around 11pm and Ophiuchus will appear directly above it in the sky.



ALLEXXANDAR/ALAMY

In the southern hemisphere, if you have a clear view of the Milky Way you will be able to see all of Scorpius, easily recognised by the long arc of its tail and the three stars in a line at its head. It will be in the east and will cross the band of the Milky Way. It is best to wait an hour or two after sunset, then look to the east. Directly above the horizon you will see Antares, with Sabik below it. The rest of Ophiuchus lies down and to the north. Again, on 4 June, the moon will form a triangle with Antares and Sabik.

The question of whether Ophiuchus is a zodiacal constellation depends on how exactly these constellations are defined. Generally, the zodiacal constellations are those that cross the ecliptic, the path the sun appears to trace in the sky, and Ophiuchus crosses the ecliptic just as much as any of the other zodiacal constellations.

Some astronomers say the zodiacal constellations are those through which planets pass. In that case, we would have to include more constellations because the paths of the planets cover a larger area of the sky. According to John Mosley, formerly at Griffith Observatory in California, there are 21 such constellations.

Whether or not it is embraced by the astrology community, Ophiuchus is a lovely constellation, and it deserves to be better known. ▮

These articles are posted each week at newscientist.com/maker

SPECIAL READERS OFFER

100% COTTON

PLEATED CHINOS

only **£50** buy 2 for £90 **SAVE £10**

PETER CHRISTIAN

Gentlemen's Outfitters

A traditional pleated front ensures a generous cut and all day comfort. Our classic 100% cotton chinos are cut with single pleats plus they boast our discreet expanding comfort waistband. Finished to the highest standards; elegant with a jacket and shirt, or casual with your favourite sweater. Essential trousers, all year round.

- 100% cotton
- French bearer fly for a secure front
- Hidden expanding waistband allows for 2" of flexibility
- 2 buttoned hip and 2 deep side pockets
- Money Back Guarantee**

Colours: Navy, Sand, NEW Blue, Sage, Tan, Stone, Green

Waist: 32 34 36 38 40 42 44 46 48 50 52"

Leg: 27 29 31 33"

FREE DELIVERY* SAVE £5 + Free Returns** use code **51H22**

"...I have purchased mens chinos elsewhere but none are as good as yours – Outstanding." John

★★★★★ Trustpilot RATED **EXCELLENT**



Order Pleated Chinos (MT06)

Use code **51H22** for **FREE P&P**

peterchristian.co.uk

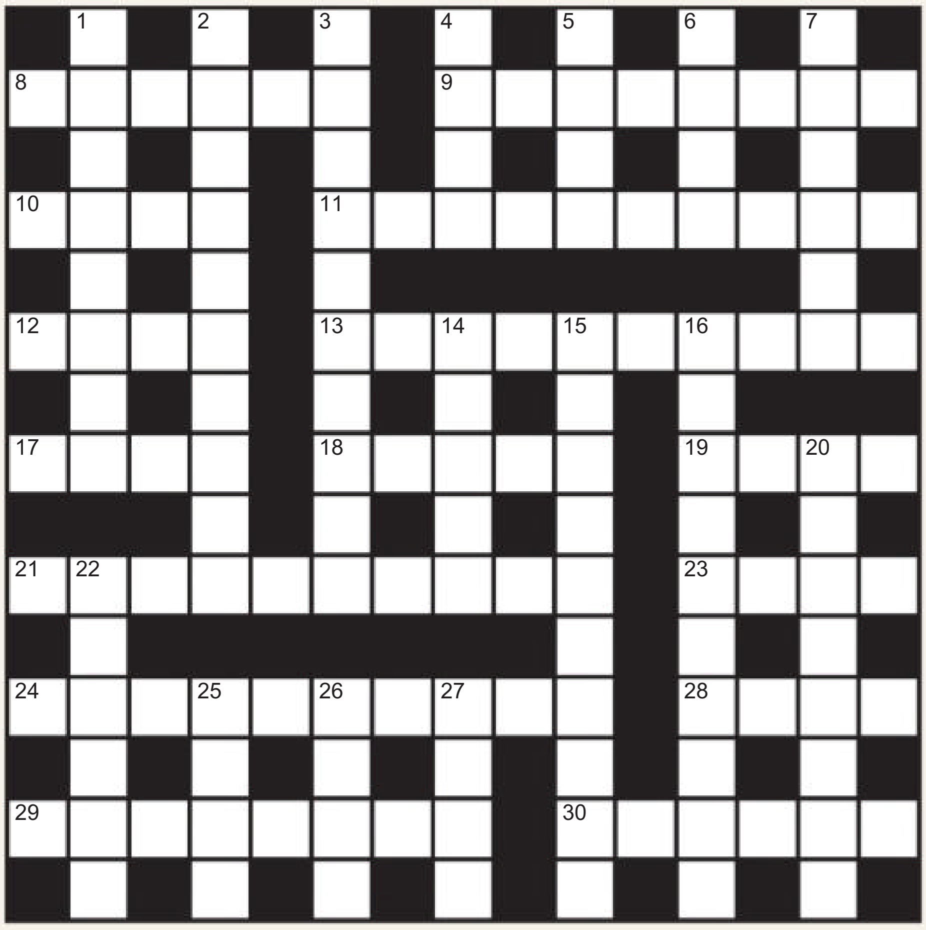
01273 493 393 Mon-Fri 8am-Midnight Sat-Sun 8am-8pm

Order by post – Cheques payable to Peter Christian. Quote **51H22** and send to: Freepost PETER CHRISTIAN

Go Online or Call for a Free Catalogue

*Free UK delivery (normally £5). Offer ends midnight 03/08/23. £50 Minimum spend applies.
**Free returns within the UK only and subject to items being in perfect condition, in their original packaging and returned within 30 days. A Division of Hills of Bramley Ltd. Co Reg No 04767802

Quick crossword #134 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

8 Type of high-altitude cloud (6)
9 Red-banded form of chalcedony (8)
10 Zn (4)
11 Cd, Hg or Pb, perhaps (5,5)
12 Clay mineral, $Mg_3Si_4O_{10}(OH)_2$ (4)
13 Optical superpower (1-3,6)
17 Round geometric shape (4)
18 In, or surrounded by (5)
19 I (4)
21 Heaviness of an inert body (4,6)
23 Coloured part of the eye (4)
24 "Go", in a traffic signal (5,5)
28 Inactive (4)
29 Drool (8)
30 Os (6)

DOWN

1 Country in the time zone UTC+14:00 (8)
2 Compound found in brassica seeds, $CH_3(CH_2)_7CH{=}CH(CH_2)_{11}COOH$ (6,4)
3 Deprive of oxygen (10)
4 Vast landmass east of Europe (4)
5 Obsolete system of weights (4)
6 High-carbon coal residue (4)
7 Electrical generator (6)
14 From end to end of; over the length of (5)
15 Foliage (10)
16 *Solaris* and *Bladerunner*, perhaps (3-2,5)
20 Test (of a process) (5,3)
22 Cerumen (6)
25 Give out (4)
26 Photosynthetic plant appendage (4)
27 ___ squirrel, arboreal rodent (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #204
set by Bethan Ackerley

1 In which country is the spaceport that was first able to carry out orbital and human launches?

2 What are the pores on the outer layer of a leaf called?

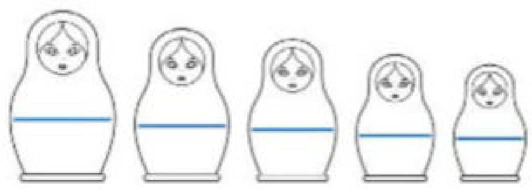
3 Fermi's interaction is an explanation of which kind of radioactive decay?

4 In what year was Charles Darwin's *On the Origin of Species* published?

5 The sense of one's own internal bodily signals, such as heart rate, is known as what?

Answers on page 55

Headscratcher
set by Holly Biming
#224 Russian dolls



I collect Russian dolls, the type where each doll can be opened to reveal a smaller one inside. I am particularly fond of my simple, single-coloured ones, which come in sets of five (and, unusually, have a hollow smallest doll). I have five lovely sets of them, each a different colour.

Alas, while I was out, my daughter Kira rearranged them so that each large doll now contains one each of the four other colours. She proudly tells me that no blue doll contains a doll that has a yellow doll anywhere within it. There is no doll that contains a pink doll with a red doll anywhere within it. And no yellow doll contains a green doll with a pink doll anywhere within it.

"By the way, have you seen my wedding ring?" I ask her.

"Ah, I put that inside the smallest blue doll," replies Kira.

Which coloured doll should I open first if I want to find the ring as quickly as possible?

Solution next week

Veni, vidi, vici

Do we actually know how the ancient Romans pronounced Latin words?

Eric Kvaalen
Les Essarts-le-Roi, France
We have three sources of information: languages that are descended from Latin; the Proto-Indo-European language, from which most languages in Europe and southern Asia descended; and transliterations (phonetic spellings) of Latin words in other languages of its time.

In the Romance languages, which descended from Latin, many letters are pronounced identically, or almost, such as b, d, f, k, l, m, n, p, t and x, and we can be pretty sure that these letters were pronounced the same in Latin. Some of these sounds were also pronounced the same in Proto-Indo-European. For example, most Indo-European languages have a word for mother related to the word "mother", and they all pronounce the "m" as we do.


REUTERS/JON NAZCA

When did people first realise that the lit portion of the moon always faces the sun?

This week's new questions

Spotlight on moonlight **When was it first realised that the lit portion of the moon always faces the sun, so moonlight must be reflected sunlight?** ***Andrew Taubman**, Sydney, Australia*

God of thunder **In the comics, Thor spins his hammer very fast and hurls it into the air, allowing him to be pulled into flight. Could you make a machine that "flew" using such a principle?** ***Paul Gray**, Hertfordshire, UK*

"Roman plays can give clues about how Latin was pronounced, by suggesting where there must be puns and homophones"

Latin words were sometimes written in other languages at the time it was spoken. For example, the Latin name Vespasian can be found in the writings of Josephus, in ancient Greek, where it is spelled Ουεσπασιανος, which is Ouespasianos when transliterated into Latin letters. The "ou" at the beginning is normally used for a long "u" sound (the sound in "too"), so this tells us that the Latin "v" was probably pronounced like a "w", not like "v" in the Romance languages or English.

Another example is the word *centurio* (centurion). Nowadays, in most languages the "c" is soft, but in Greek it was written κεντυριων, which starts with kappa, the Greek equivalent of "k", showing that "c" was hard at that time, even when followed by "e".

Greek words were also borrowed by Latin, and "c" was used for kappa even when followed by vowels like e, i or y, such as *cinnamomum* for "κινναμωμον" (cinnamon).

Dave Bath
Melbourne, Australia
Sometimes, we know exactly how to pronounce a Latin word, perhaps aided by the works of the Roman grammar police, tut-tutting at barbarians. Sometimes, spelling errors can give strong clues, as in "I got pills from the farmassy".

As Roman verse was rhythmic, we can discover which syllables were stressed, similar to how we discovered what rhymed in Elizabethan times, but perhaps not now, by looking at the works of William Shakespeare ("If this be error, and upon me proved, I never writ, nor no man ever loved"). Roman plays can help by suggesting where there must be puns and homophones, or by poking fun at the pronunciation of foreigners or the lower classes.

Other clues come from what the words morphed into over the centuries – but that is more subtle.

Connaire Kensit
Retired lecturer in linguistics
London, UK
Reconstructing the pronunciation of Latin, a language that still exists in modern forms (Portuguese, Castilian, Catalan and French, for example), is simple, if tedious.

You need training in distinguishing, reproducing, describing and notating the full range of human speech sounds. Also, you need references for modern pronunciations in the descendant languages, which evolved from Latin by the familiar process of young speakers copying older ones.

From here, you just have to ensure that there is an unbroken series of plausible sound changes leading from your reconstructed past pronunciation to all of the modern pronunciations it has evolved into. A sound change is plausible if you can observe it in progress in any language.

A past language with plenty of written texts is particularly easy to reconstruct: verse that rhymes is helpful, as are renderings of foreign words and names. Other useful tools include observations made by writers of the time: Quintilian, Cicero and others made comments on Latin speech that they heard.

For a good and well-evidenced reconstruction of Latin, see W. Sidney Allen's *Vox Latina: A guide to the pronunciation of classical Latin* (1965).

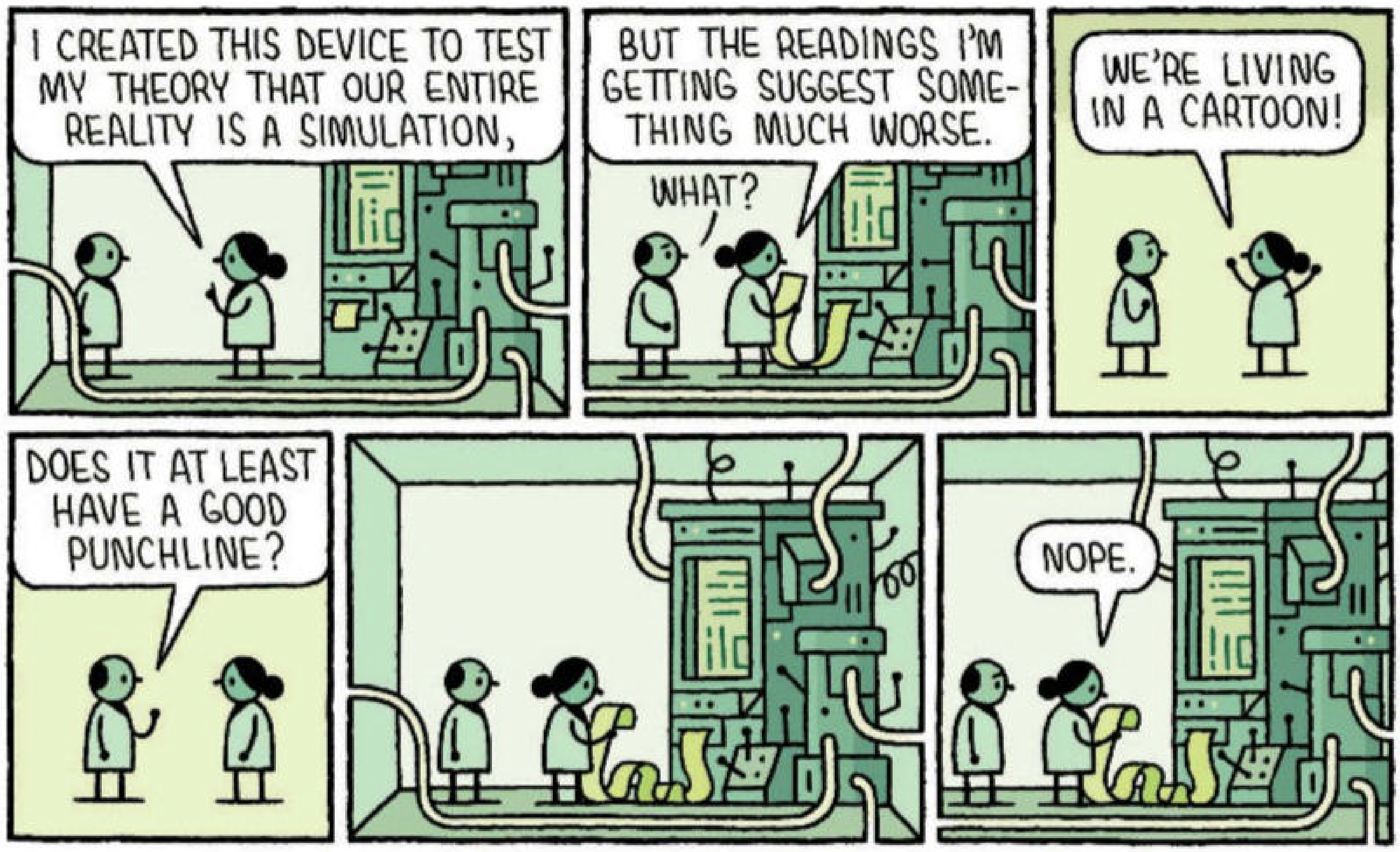
Faith Anstey
Dalguise, Perth and Kinross, UK
As a field botanist, I am sometimes asked about the "correct" pronunciation of scientific (Latinate) names. My answer is: "The right way to pronounce them is loudly and with great confidence, so that everyone will believe you know what you are talking about." This has always worked for me.

Put the kettle on

Having read several recent articles on nutrition and longevity, I wonder how many life-extending cups of tea I must drink to counter the life-shortening effect of eating a hot dog?

Want to send us a question or answer?
Email us at lastword@newscientist.com
Questions should be about everyday science phenomena
Full terms and conditions at newscientist.com/lw-terms

Tom Gauld
for New Scientist



Tim Bond
Tea Advisory Panel, London, UK
Eating processed meat, such as hot dogs, is associated with increased mortality, possibly due to increased intake of salt, saturated fat or the additives used for curing.

A study in *JAMA* analysed data from six US studies involving a total of 29,682 participants, and found that higher intakes of processed meat were associated with a small increase in death from all causes. Those eating two servings of processed meat per week had a 3 per cent increase in their risk of early mortality, which equates to an absolute risk difference of 0.9 per cent over the course of 30 years.

While we don't have a direct comparison with tea in this set of studies, we do have data from a UK Biobank study that involved 498,043 men and women aged between 40 and 69 years.

Over a period of 11 years, drinking two to three cups of black tea daily was linked to a 13 per cent reduced risk of early mortality compared with no tea drinking. This suggests that two cups of tea a day is sufficient to overcome the negative effects of a twice-weekly hot dog habit.

"This suggests that two cups of tea a day is sufficient to overcome the negative effects of a twice-weekly hot dog habit"

Flavonoids are the key components that make tea a healthy drink. They act as antioxidants, which control the damaging inflammatory effects of substances called free radicals. Both black and green teas have similar overall levels of flavonoids, albeit with different proportions of the various types.

Green tea is richest in a flavonoid called epigallocatechin-3-gallate, while black tea is richest in theaflavins and thearubigins. Herbal teas contain flavonoids too, but their concentrations and types will vary depending on the kind of plant.

Octopus tech

If an intelligent marine species like the octopus evolved to live on land, what is the likelihood it would develop technology? (continued)

Robert Peck
York, UK
While octopuses developing tool use may seem plausible, any octopus civilisation would, living underwater, be unable to access fire. This would potentially limit any of the technologies octopuses could develop to being pre-industrial, as, without fire, they would struggle to attain the temperatures needed for metal smelting and forging.

Coming out on to land briefly at low tide may provide a workaround here, as might accessing heat from deep-sea volcanic eruptions. The lack of an available heat source would also be a problem when considering if underwater extraterrestrial life, such as might exist below the ice on Europa, could ever become technically advanced.

Answers

Quick quiz #204 *Answers*

1 Kazakhstan
2 Stomata
3 Beta decay
4 1859
5 Interoception

Cryptic crossword #110 *Answers*

ACROSS 1 Ache, **3/21** Anechoic chamber, **9** Roll out, **10** Raise, **11** Cumulonimbus, **13** Ermine, **15** Statue, **17** Adrenal gland, **20** Salsa, **22** Seaweeds, **23** Bred

DOWN 1 Auricles, **2** Hilum, **4** Natant, **5** Chromatogram, **6** Oviduct, **7** Cues, **8** Coelenterate, **12** Tendered, **14** Medulla, **16** Rancid, **18** Arbor, **19** Asps

#223 Setting the right tone *Solution*

Leo needs to mix five parts of the first dollop of paint with four parts of the second dollop.

One third of each dollop is always blue, so we only need to consider the yellow and red paint. Each measure of the second dollop has five units of yellow and three of red, for a total of eight. The same measure of the first dollop will give us four units of each.

We want to have yellow and red paint in a ratio of 5:4, which is 40:32 in multiples of 8. Since each measure of the second dollop gives us two more units of yellow paint than red, four measures are required to create a gap of eight units between the two colours (20 yellow, 12 red). Adding five measures of the equal mixture increases this to 40:32. Hence, we need five parts of the first dollop to four of the second.

A jerk and a creep

"Hidden jerk in universal creep and aftershocks" may sound like the name of a Hollywood movie – and maybe some day it will be. But for now, it is exclusively the title chosen by Vikash Pandey at Krea University in India for a mathematical physics write-up that involves earthquakes, avalanches, landslides and bamboo chopsticks. And, indirectly, spaghetti. It was published in *Physical Review E*. Allan Harvey brought it to Feedback's attention.

Jerk, as most calculus students are amused to learn, is the technical word for the rate at which acceleration changes. In the haughty language of the trade, jerk is, as Feedback recalls it, "the third derivative of displacement, the second derivative of velocity and the first derivative of acceleration".

Creep, as most mechanical engineering students are pleased to discover, is a term for the tendency of a solid material to slowly change shape as it is being stressed.

Calculus, physics and engineering are a playground for people who like words. In his paper, Pandey proposes three new bits of jargon – "jerken", "jerkity" and "the coefficient of jerkity" – each of which would take more space to define than Feedback is willing or able to donate.

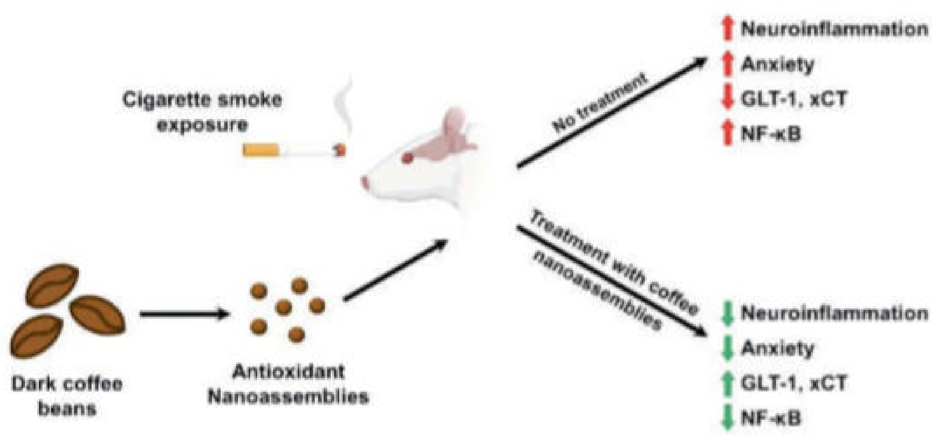
The spaghetti is invoked in a study that Pandey cites, called "Acoustic emission from breaking a bamboo chopstick". The final page of that study includes this memorable phrase: "the data for spaghetti appeared more scattered than those for the chopstick in Figure 3". Explaining why and how that phrase is pertinent to this discussion of a jerk and a creep would, as with explaining the terms "jerken", jerkity" and "the coefficient of jerkity", exceed the amount of space available here.

Lighting up

Physicists aren't the only researchers hurtling in pursuit of a Theory of Everything: a simple, coherent story that explains many mysteries and that it is possible to verify through experiments.

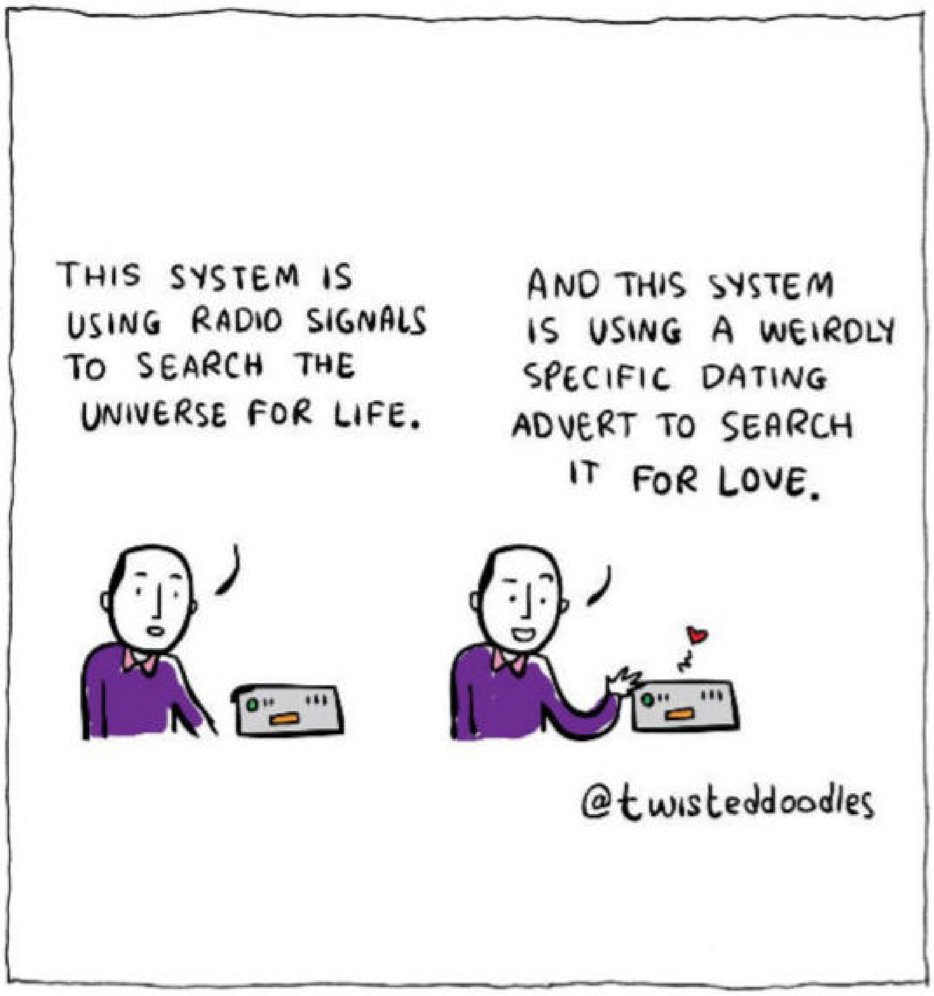
A new study called "Nanoassemblies from the aqueous extract of roasted coffee beans modulate the behavioral and molecular effects of smoking withdrawal-induced anxiety in female rats" holds promise of realising the dream. It sews together many worlds of inquiry, almost defying any attempt to reduce the project down to a suitable, snappy summary.

The researchers behind the study, perhaps realising that people outside their fields might feel intimidated, provide a quietly charming graphical abstract (below). The artistically overwhelming power of the whole thing derives from the striking proximity – and similarity in size and colour – of the rat's eye and the glowing tip of the cigarette. The rat's head and the cigarette each float in space, compelling the reader's attention.



SUHAIR SUNOQROT, PHD

Twisteddoodles *for New Scientist*



Got a story for Feedback?
Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

How long you will live

Two denizens of the department of demography at the University of California, Berkeley, did some calculations about a popular life-and-death question. The question: how much should you trust mathematical recipes that predict how long a person will live?

Casey Breen and Nathan Seltzer explain their calculations, summarising them with the title "The unpredictability of individual-level longevity". They used "eight machine learning algorithms using 35 sociodemographic predictors" to predict the lifespans of 130,000 people. They compared the predictions against those people's actual birth and death dates listed in old census records.

They take from this a cheerily dour assessment: "We find that none of these algorithms are able to explain more than 1.5% of the variation in age of death. Our results point towards the unpredictability of mortality and underscore the challenges of using algorithms to predict major life outcomes."

Do remind yourself that a few seconds ago, when you began to read this item, you were making the prediction that you would live long enough to read the item all the way through to its end.

Unfunnelled powers

Clive Teale confides having a trivial superpower that is rarely mentioned in polite or other company, maybe because it is rare. His confession adds to Feedback's growing list of such superpowers.

Clive says: "Sadly now too old (at 79) to do this, when younger I could reliably demonstrate the ability to pour petrol from a gallon can into a motorbike tank without a funnel and without spillage."

Tealean Petrol Pouring also belongs in the (as yet nonexistent) catalogue of Debatably Admirable Human Activities. ▮

Marc Abrahams

New Scientist Jobs

METRO .co.uk



LGBTQIA+ experience in STEM survey

New Scientist Jobs and Metro.co.uk are conducting a survey to understand the experience of the global LGBTQIA+ community in STEM.

If you are part of the LGBTQIA+ community and work in STEM, we would love your thoughts and feedback.

Complete the survey today

newscientist.com/lgbtqia+



Shop at omegawatches.com

DISCOVER NEW DEPTHS

Our world record dive to the deepest place on Earth, led to a groundbreaking OMEGA dive watch. Every 45.5 mm timepiece in the Seamaster Planet Ocean Ultra Deep collection is a Co-Axial Master Chronometer, water resistant to 6,000 metres. Including this model, made in our own O-MEGASTEEL, with black ceramic bezel, lacquered blue to black gradient dial, and beautifully matching black rubber strap with cyan lining.

Ω
OMEGA